

Final Programmatic Environmental Assessment

Wastewater Management Improvements in the Florida Keys, Florida



Prepared For
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*NOTE: Those words whose first occurrence is in bold text in the document body are defined in Appendix B for reader assistance.

1.1 DISASTER BACKGROUND AND FEMA REGULATORY GUIDANCE

In 1998, after Hurricane Georges, Congress enacted Public Law 106-31, Emergency Supplemental Appropriations Act for Fiscal Year 1999, to provide additional monies for long-term disaster recovery projects in the State of Florida. The funds were allocated to assist counties whose needs were yet unmet through allocation of primary disaster relief funds. This Unmet Needs money was earmarked for the counties most impacted by Hurricane Georges, including Monroe County. The Federal Emergency Management Agency (FEMA), State of Florida, and the impacted counties determined funding priorities. Monroe County requested that wastewater management improvement projects be considered for disaster funding since many existing wastewater facilities in Monroe County are not storm-resistant, do not provide adequate treatment, and contribute greatly to degraded water quality in the Keys. Since then, FEMA has received grant applications from the Village of Islamorada (Islamorada) and the Keys Aqueduct Authority (FKAA) requesting Federal assistance to upgrade or replace their existing wastewater treatment facilities.

Unmet Needs funding is a one-time distribution of funds and is administered by FEMA and the Florida Division of Emergency Management through a grant process. The Act provides communities with cost-share funds for projects that can reduce future hazard disaster-related property damages and loss of human lives. The Act's implementing regulations provide FEMA with a regulatory framework for administering these funds. These were published on August 8, 1999 in Volume 64, Number 151 of the Federal Register.

1.2 THE PROGRAMMATIC ENVIRONMENTAL ANALYSIS PROCESS

FEMA is considering the provision of funding assistance related to several proposed alternatives, which are designed to improve wastewater treatment, and ultimately water quality, in the Keys. The **National Environmental Policy Act** of 1969 (**NEPA**), Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500 to 1508), and FEMA regulations for NEPA compliance (44 CFR Part 10) direct FEMA to fully understand and take into consideration during decision making, the environmental consequences of proposed Federal actions (projects). Accordingly, FEMA prepared this **Programmatic Environmental Assessment (PEA)** on the effects of implementation of a range of wastewater collection, treatment, and disposal alternatives proposed in the Keys. The study area for the PEA encompasses the Florida Keys and its nearshore waters (Figure 1-1).

FEMA has determined through experience that the majority of the typical recurring actions proposed for funding, and for which an Environmental Assessment (EA) is required, can be grouped by type of action or location. These groups of actions can be evaluated in a PEA to comply with NEPA and its implementing regulations without having to produce a stand-alone EA for every action.

FIGURE 1-1, VICINITY MAP

Because actions proposed for funding under this PEA and impacts of these actions can vary based on location, alternatives, and other site-specific criteria, a **supplemental environmental review** document (**SER**) will be prepared for each individual project covered by this PEA. The resulting SER will tier off this PEA, in accordance with 40 CFR Part 1508.28, and consist of either a **Supplemental Environmental Assessment (SEA)** or **Environmental Impact Statement (EIS)**. Projects for which it has been determined that potentially **significant**, adverse impacts exist will go through the EIS process as required by NEPA.

This PEA applies to centralized wastewater improvement actions and on-site system upgrades using nutrient removal systems proposed for FEMA funding. The analysis in this PEA has relied upon FEMA's historic experience of project typology, description, and consequences described in environmental documents (Categorical Exclusions [CATEXs] and EAs). Analysis in this PEA is also based on review of scientific literature, consultation with regulatory agencies, and expert opinion. To support the data presented in this document, Appendix G has a list of State and Federal agencies consulted during this analysis; Section 7 lists the individuals involved in the technical research, evaluation, writing, and peer review of this PEA and their experience; and Section 8 provides a summary of text, internet, and interview references used to create this document. The conclusions of the PEA are summarized in Section 6.

1.3 THE IMPACTS OF WATER QUALITY DEGRADATION IN THE FLORIDA KEYS

The complex and dynamic environment of the Keys is reliant upon clear waters, low in nutrients and sediment, to support numerous endemic species, sustain the world's third largest coral reef system, and provide the economic lifeblood of the Keys in terms of tourism and the fishing industry. While the beauty and diversity of environmental attributes in the Keys create a world-renowned location, those same attributes draw millions of visitors a year to the Keys and have provided reason for a boom in population growth and rapid development. Human activities have negatively impacted the ecological balance of the Keys ecosystem where changes to the physical-chemical conditions that result in direct effect on one community type can affect adjacent community types (Voss, 1988; Kruczynski, 1999). The continued degradation in water quality and in the abundance and vitality of seagrass beds, coral reefs, and numerous marine species is evidence that the cumulative effects of continued nutrient loading from the Keys and other sources is upsetting the Keys equilibrium. The economy and quality of life of Keys residents, which depend upon a vital marine environment, are being affected. Fecal contamination resulting from poorly treated wastewater, presents not only a public health risk, but could lead to additional beach advisories, which may affect tourism in the long-term if degraded water quality is left unabated. Considering that 70% of tourism in the Keys, which generates over \$1.3 billion per year and supports over 21,000 jobs, is founded on water-based activities such as fishing, snorkeling, beach activities, and observing wildlife and nature (English, et al., 1996), it seems that the way of life in the Keys is dependent upon good water quality. It should be noted that improving wastewater treatment would improve the water quality of inland and nearshore waters; however, pollution from wastewater is only one of several sources of contamination as described in the following section.

1.4 SOURCES OF KEYS WATER QUALITY DEGRADATION

Wastewater treatment and management and stormwater management practices in the Keys have not advanced to serve the growing Keys populations adequately. Many recent studies evaluating the state of the Keys environment conclude that wastewater discharges and stormwater runoff and canal flushing contribute greatly to water quality degradation. Of the nutrient pollution emanating from the Keys, discharges from **septic tanks**, **cesspits**, and shallow (90 feet) **injection wells**, account for 80% of the nitrogen and 55 to 56% of the phosphorus loading to nearshore waters. Similarly, 20% of the nitrogen and 44 to 45% of the phosphorus loads from the Keys to the nearshore waters are deposited by stormwater runoff (EPA, 1996; Kruczynski, 1999).

In addition to the Keys' inadequate stormwater and wastewater management, several additional sources of nutrient loading have been found to contribute to water quality degradation, including Florida Bay, the Gulf of Mexico, oceanic upwelling, and atmospheric deposition.

Florida Bay, a shallow embayment composed of basins separated by mud banks and mangrove islands bordering the Keys' northwestern edge, has represented a source of nutrient-rich and turbid waters to the Keys for about the last 4,000 years (Kruczynski, 1999). Cook (1997) and others have found that the turbid, nutrient-rich waters of Florida Bay is having a detrimental effect on coral reef communities seaward of the tidal passes in the Keys.

In a study examining nutrient sources to Florida Bay, Rudnick et al. (1999) found that nitrogen and phosphorus inputs from the Gulf of Mexico greatly exceeded inputs from the Everglades National Park in South Florida. The freshwater Everglades were identified with contributing less than 3% of all phosphorus inputs and less than 12% of all nitrogen inputs to Florida Bay. Additional research is required to assess the source of nutrients in the Gulf of Mexico. The nutrients entering Florida Bay from South Florida were primarily attributed to runoff from agriculture and residential areas, natural nutrient levels, oceanic upwelling and atmospheric deposition (Rudnick, et al., 1999). The oceanic upwelling in this case results from the upwelling of deep, cool, nutrient-rich water driven by the Florida current.

Although numerous studies identify water quality degradation and propose potential sources, very little quantitative data exists that specifically addresses the relative contributions to nutrient pollution in nearshore and offshore marine water in the Keys. Kruczynski (1999) emphasizes that although nutrient inputs from sources external to the Keys may be equal to or greater than **anthropogenic** loadings from wastewater and stormwater coming from the Keys; anthropogenic nutrient loadings and their effects on water quality and biological resources are no less important. As discussed in this PEA and in other studies, localized nutrient sources, such as those from on-site wastewater systems, can have immediate negative impacts that can result in "cascading" effects through the ecosystem (Kruczynski, 1999, Lapointe et al., 1990, Lapointe and Clark, 1992, Paul et al., 1995a, EPA, 1993a, and others). Additionally, wastewater nutrients seep out of the bedrock/aquifer and may cause concentration increases in canals and confined nearshore waters well above those caused from atmospheric and other sources (Kruczynski, 1999).

1.5 FOCUSING ON WASTEWATER MANAGEMENT IN THE FLORIDA KEYS

Wastewater management in Monroe County consists of a variety of collection, treatment, and disposal methods. Currently, about 23,000 private on-site systems and 246 small **Wastewater Treatment Plants (WWTP)** are operating throughout the Keys (Figure 1-2). It is estimated that of the 23,000 on-site systems, 15,200 are permitted septic systems, 640 are Aerobic Treatment Units (ATU), and 7,200 are unknown systems, of which 2,800 are suspected to be illegal cesspits (Monroe County, 2000a). Given the variety of wastewater collection, treatment, and disposal methods currently used in the Keys, effective treatment of the wastewater stream varies greatly as well.

Under **primary treatment**, large solids, settleable solids, greases, oils, and other floatable materials are separated from the wastewater. This level of treatment clarifies the **effluent** to some extent, but does not remove all the nitrogen, phosphorus, suspended solids, or other pollutants from the effluent. In general, it is estimated that primary treatment removes 40 to 50% of the organic wastes responsible for **biochemical oxygen demand (BOD)** and minimal nutrient removal. Thus, levels of nitrogen, phosphorus, and other contaminants remain high in effluent treated via primary methods (National Research Council, 1993). **Secondary treatment** uses primary treatment and a second level of either biological or chemical treatment to remove more solids and nutrients. For example, activated sludge treatment, a common form of secondary treatment, removes about 89 to 97% of **total suspended solids (TSS)** and 86 to 98% of organic wastes responsible for BOD. While a substantial improvement over primary treatment alone, this secondary process removes no more than 63% of **total nitrogen (TN)** and 66% of phosphorus (National Research Council, 1993).

On-site systems, which are common in the Keys, are much less effective at removing nutrients. Kruczynski (1999) estimates that properly functioning septic systems remove only 4% nitrogen and 15% phosphorus. An ATU system provides secondary treatment and can remove 80 to 90% of the TSS and organic wastes resulting in BOD, but is not effective at removing dissolved nutrients; in fact, an ATU removes only slightly more nitrogen than a septic system (Kruczynski, 1999). Cesspits provide little to no effluent treatment, and effluent and associated nutrients can migrate rapidly to surface and ground waters.

Overall, with exception of the WWTPs, Keys' wastewater management consists largely of systems with limited effective effluent treatment. The degraded water quality of the Keys demonstrates a need for holistic wastewater system improvements area-wide.

A number of recent studies have documented the contribution of failing septic tanks and **cesspools** to the deterioration of Keys' canal and nearshore marine water quality. Lapointe et al. (1990) and Lapointe and Clark (1992) found that the use of septic tanks increase nutrient concentrations in the groundwaters that discharge into shallow nearshore marine waters, resulting in coastal **eutrophication**. The studies attribute increased algal blooms, seagrass die-off, and the loss of coral cover on patch and bank reef ecosystems to inadequate on-site wastewater management systems. Additionally, Paul et al. (1995a) and Shinn et al. (1994) found fecal indicator bacteria in groundwater and marine waters surrounding the Keys.

FIGURE 1-2, PROCESS SCHEMATICS FOR WASTEWATER TREATMENT OPTIONS
FOR THE FLORIDA KEYS

A direct connection with septic tank waste disposal and the nearshore marine waters was shown by a viral tracer study in Key Largo. Tracers added to a domestic septic tank appeared in a canal in 11 hours and in nearshore marine waters in 23 hours (Paul et al., 1995a). An ensuing study that used a simulated injection well in Key Largo and an active disposal well in the Middle Keys found that viral tracers appeared after short periods of time in groundwater (8 hours after injection) and marine waters (10 hours and 53 hours for Key Largo and the Middle Keys, respectively) (Paul et al, 1997). The study indicated that present wastewater practices allow inadequately treated effluent to make its way rapidly to marine waters where it “may contribute to water quality degradation” (Paul et al., 1997). The U.S. Environmental Protection Agency (EPA) found that the observations and studies, together with the magnitude and extent of estimated nutrient loadings from wastewater sources are a strong indication that domestic wastewater sources are regionally substantial (EPA, 1993a).

1.6 WATER QUALITY DEGRADATION AND LONG-TERM RECOVERY

Most of the Keys are characterized by low land elevations, which when combined with a proximity to ocean waters, render the Keys susceptible to storm-surge flooding. Given these characteristics, the vast majority of the Keys are mapped within the designated 100-year floodplain (FEMA, 1999). Disaster mitigation is important in the Keys not only to strengthen the Keys’ resistance to flood damage on the whole, but also to prevent further degradation of marine waters. As stated previously, the Keys have numerous cesspits and septic systems, which by the nature of their operation and of the soils in the Keys, communicate with shallow groundwater and nearshore waters. When storm surge events occur, ocean water can surge beyond the beach zone and flood developed areas, including the cesspits and septic systems. When this occurs, effluent and associated contaminants are flushed from the cesspits, and from the shallow limestone, ultimately discharging to the nearshore waters. Protecting the Keys against storm surge flooding would be a difficult task; however, improving wastewater treatment practices is less difficult and can reduce storm surges from aggravating already degraded water quality.

While coral reefs provide substantial ecological and recreational functions, they also provide a protective offshore structural barrier to catastrophic waves and storm surges generated by tropical storms and hurricanes (USGS, 1997). Coral reef systems worldwide have deteriorated to the extent that 30% of all reefs have reached the critical stage, another 30% are seriously threatened, and that less than 40% are considered stable (Wilkinson, 1993; 1996). In the Keys, six areas of coral reef systems were monitored for seven years by Porter and Meier (1992), who found that all six areas lost between 13 and 29% of their species richness, with a net loss of 7.3 to 43.9% of their coral cover. While the direct cause of the observed accelerated deterioration is difficult to clearly define, the primary factors include nutrient enrichment, sediment loading, over-fishing, and physical damage (Kruczynski, 1999). Continued water quality degradation may contribute to the decline in coral reefs, potentially reducing the long-term effectiveness of storm surge and wave flooding protection.

1.7 WATER QUALITY PROTECTION MEASURES AT THE LOCAL, STATE, AND FEDERAL LEVELS

Wastewater treatments in the Keys has become a significant concern to Monroe County, the State of Florida, and U.S. lawmakers. In response to decreased Keys' water quality, a number of laws, regulations, and standards have been promulgated by Federal, State, and local agencies, including the EPA, National Oceanic and Atmospheric Administration (NOAA), U.S. Army Corps of Engineers (USACE), State of Florida Departments of Environmental Protection (FDEP) and Health (FDH), FCAA, South Florida Water Management District, Florida Keys National Marine Sanctuary (FKNMS), and Monroe County. The Keys' marine environment is also managed through the FKNMS, whose geographic area covers the entire stretch of the Keys, and whose technical advisory and steering committees include representatives from the aforementioned organizations, along with the U.S. Fish and Wildlife Service (USFWS), Everglades National Park, Florida Keys Environmental Fund, and the City of Key Colony Beach and the Key Largo area. This section is a summary of wastewater management improvement regulatory milestones and the intent behind each mandate and plan (Section 3.2 discusses Water Quality and Water Resources in detail).

A number of Federal, State, and local laws and regulations govern water quality in the Keys including the Florida Keys National Marine Sanctuary and Protection Act, Clean Water Act (CWA), Resource Conservation and Recovery Act (RCRA), and EPA's Ocean Discharge, Gulf of Mexico, and Underground Injection Control (UIC), among others. Most notably, Monroe County and the State of Florida have established mandates over the last seven years specifically to improve wastewater treatment methods in the Keys (Table 1-1).

Concerned about the water quality in the Keys, the *Monroe County Year 2010 Comprehensive Plan*, adopted in final version by the county in 1997, mandates that nutrient loading levels be reduced in the Keys' marine ecosystem by the year 2010. In 1998, the Florida Governor issued **Executive Order (EO) 98-309** that charged local and State agencies with coordinating with Monroe County to execute the *Year 2010 Comprehensive Plan* to eliminate cesspits, failing septic systems, and other substandard on-site sewage systems. The EO also required that all wastewater discharge be treated to **Advanced Waste Treatment (AWT)** levels or **best available technology (BAT)** (these standards are referred to as the **Florida Statutory Treatment Standards** in this document). Passed by Florida Legislature in 1999, Florida Law (F.L.) 99-395 pertains to on-site sewage treatment and disposal systems (OSTDSs), and includes specific requirements for all sewage treatment, reuse, and disposal facilities and all OSTDSs in Monroe County. The provisions prohibit any new or expanded discharges into surface waters, and require that existing surface water discharges be eliminated before July 1, 2006. The law also establishes effluent standards produced by sewage facilities of varying capacity.

To meet regulatory requirements and achieve water quality improvements, Monroe County prepared the Sanitary Wastewater Master Plan (MCSWMP) (Monroe County, 2000a) that defines specific planning areas for the entire developed areas of the Keys (except for the cities of Key West and Key Colony Beach). The MCSWMP also addresses wastewater management alternatives including the construction of new treatment plants, conversion of **on-site wastewater treatment systems (OWTS)** to **on-site wastewater nutrient reduction systems (OWNRS)**, use of **cluster systems** (i.e., OWNRS that accommodate multiple homes), effluent disposal, and wastewater collection. The MCSWMP identifies preferred alternatives to

improving wastewater treatment in the Keys via an extensive decision model process, which is detailed in Section 2, Alternatives Evaluated, in this document. The alternatives evaluated in this PEA parallel the preferred alternatives identified in the MCSWMP.

Additionally, in 1998 the Florida Legislature amended the enabling legislation of the FKAA (F.L. 76-441) to reinforce the FKAA's involvement in wastewater for Monroe County. The FKAA is the main potable water supplier for the Keys. A Memorandum of Understanding (MOU) between Monroe County and the FKAA was signed to "request that the FKAA exercise its authority to purchase, finance, construct, and otherwise acquire and to improve, extend, enlarge, and reconstruct a wastewater collection, transmission, treatment, and disposal system or systems in the Florida Keys."

Table 1-1 - Recent Chronology of Regulatory Milestones of Wastewater Management in the Florida Keys

1993	<ul style="list-style-type: none"> Initial adoption of Monroe County Year 2010 Comprehensive Plan.
1997	<ul style="list-style-type: none"> Monroe County Comprehensive Plan Amended to comply with Florida Statutes. Administration Commission adopts amendments to Monroe County Year 2010 Comprehensive Plan and established Five-year Work Program (Rule 28-20.100). MCSWMP begins. Monroe County established original Identification and Elimination of Cesspools Ordinance, 03-1997; this ordinance was unsuccessful and was later rescinded.
1998	<ul style="list-style-type: none"> Governor's Executive Order 98-309 (State and Local Agency Participation in Carrying Out Monroe County Year 2010 Plan). Florida Legislature amends the enabling legislation of the FKAA (F.L. 76-441) to reinforce the FKAA's involvement in wastewater for Monroe County Monroe County enters into a Memorandum of Understanding with the FKAA requesting that the FKAA exercises its authority to finance, construct, and operate wastewater systems in the Keys
1999	<ul style="list-style-type: none"> Governor Bush and his cabinet amend the 1997 Five-Year Work Program (Rule 28-20.100) to accelerate pace of program, identify "Hot Spots," and initiate cesspool identification outside of "Hot Spot" areas. Monroe County passes ordinance 031-1999 (Revised Identification and Elimination of Cesspools) to comply with the Governor's revised Five-Year Work Program. F.L. 99-395 passed (New requirements for all sewage treatment, reuse and disposal facilities, and all on-site systems Monroe County; prohibits new or expanded discharges into surface waters, and require existing surface water discharges be eliminated before July 1, 2006).
Source: Modified from Monroe County, 2000a	

1.8 PURPOSE AND SCOPE OF THE PEA DOCUMENT

The purpose of this document is to facilitate FEMA's compliance with NEPA and associated environmental and historic preservations laws and regulations, by providing a framework to evaluate several wastewater treatment project alternatives feasible in the Keys. This document evaluates projects that were originally proposed by Monroe County in its MCSWMP (2000a).

This PEA discusses the potential environmental effects from implementing various wastewater collection and disposal project alternatives fully or partially funded by FEMA. Section 3 describes the range of potential effects on resources associated with the Alternatives. This PEA also provides the public and decision-makers with the information needed to understand and evaluate these potential environmental consequences. Section 4 discusses cumulative impacts, which would also be discussed in the SER. This PEA applies immediately to all projects described in Section 2 of this document, which have been proposed for FEMA funding. The description of proposed actions by alternative action category is provided in Section 2.

1.9 PURPOSE OF AND NEED FOR ACTION

Wastewater treatment in the Keys has become a significant concern to Monroe County, the State of Florida and U.S. lawmakers. Numerous scientific studies have documented the contribution of failing septic tanks and cesspools to the deterioration of Keys' canal and nearshore water quality (Lapointe et al., 1990; Lapointe and Clark 1992; Paul et al., 1995a; Shinn et al., 1994; Paul et al., 1997; EPA, 1993a; Kruczynski, 1999 and others). The *Monroe County Year 2010 Comprehensive Plan* mandates that nutrient loadings be reduced in the marine ecosystem of the Keys by the year 2010 and that wastewater systems meet more stringent Florida Statutory Treatment Standards. In light of regulatory requirements and in the interest of protecting public health and water quality, the purpose of the FKAA and the Village of Islamorada projects is to reduce wastewater nutrient loading at selected County identified hot spots. Due to the high capital cost of implementing these improvements, the project applicants have applied for FEMA grant funding, through the Unmet Needs program established under P.L. 106-31, to help achieve their wastewater treatment objectives.

1.10 PUBLIC PARTICIPATION PROCESS AND REGULATORY FRAMEWORK

The topic of wastewater management improvements and water quality degradation in the Keys is of particular public interest to agencies and citizens alike. For this reason, public participation throughout the PEA and SER processes is of high concern not only in terms of upholding the intent of NEPA and other applicable environmental statutes, but also to ensure that FEMA conducts studies with the knowledge that public and agency opinions were gathered and considered, ensuring a well-documented and well-represented study. FEMA has specific requirements for public participation in compliance with its implementing regulations for NEPA, EO 11988 (Floodplain Management) and EO 11990 (Wetland Protection) and EO 12898 (Environmental Justice). Furthermore, as described in Section 5, Monroe County has conducted public involvement in relation to the development and issuance of the MCSWMP that guides future wastewater management activities in the Keys. Additional information on FEMA's public involvement activities, as of PEA release, and the environmental review process is further detailed in Section 5.

2.1 ALTERNATIVE DEVELOPMENT BACKGROUND

Wastewater treatment in the Keys has come to the forefront as a principal concern to both the State of Florida and Monroe County. Several planning objectives, county ordinances, and State standards were established to set goals and guidelines to direct wastewater treatment and management improvements in the Keys (these mandates are discussed in Section 1, Introduction, and in Section 3.2, Water Resources and Water Quality, of this document). In essence, these mandates urge water quality improvements through development of wastewater management solutions, establishment of more stringent nutrient limits, participation of relevant agencies and entities in making wastewater management improvements, and identifying and eliminating cesspools. These mandates were developed to provide holistic changes in how wastewater is managed at all levels, from the Federal agency to the county resident.

While there are several contributing sources of water quality degradation in the Keys, Monroe County narrowed their focus on improving the wastewater management methods and associated infrastructure within the county. As mentioned in Section 1, Monroe County has both WWTPs and on-site systems. On-site systems are estimated to contribute 4.88 million gallons per day (mgd) of wastewater, and WWTPs contribute 2.40 mgd of wastewater. None of the on-site systems or WWTPs provide adequate nutrient removal, with effluent from all facilities having nutrient levels that exceed the Florida Statutory Treatment Standards (Monroe County, 2000a).

To further focus their efforts, Monroe County evaluated the existing county treatment areas and identified several high priority “Hot Spots” believed to substantially contribute to water quality degradation (Figures 2-1, 2-2, and 2-3; Appendix C). These “Hot Spots” were identified based on population density, nutrient discharge, and the number of unpermitted on-site waste disposal systems. These “Hot Spots” represent priority areas where the high concentration of people and poor existing wastewater management practices (such as cesspools) justify the installation of a more advanced wastewater treatment system (such as a WWTP) within that area. In accordance with the MCSWMP, wastewater system improvements would be focused first within these “Hot Spot” areas, and then proceed outside these areas when priority improvements were complete. In support of this approach, the alternatives presented in this PEA and in subsequent SERs are proposed for dense, urban areas.

2.2 DECISION MODELS FOR WASTEWATER MANAGEMENT ALTERNATIVE DEVELOPMENT

The alternatives presented herein parallel alternatives studied and approved for consideration by Monroe County, as in the MCSWMP (2000a). The decision-making process for wastewater management involves a comprehensive evaluation of many variables, and ultimately, prioritizing those variables. Specifically, the Monroe County Citizens Task Force on Wastewater (Task Force), Sanitary Wastewater Master Plan Technical Advisory Committee (SWMP TAC), and Board of County Commissioners (BOCC), together with representatives from the community at large, developed the models and considered the alternatives in terms of cost, technical feasibility, performance, environmental impacts, potential for service disruption, reliability, implementation, and strength and weaknesses in order to evaluate alternatives.

FIGURE 2-1 UPPER KEYS

FIGURE 2-2 MIDDLE KEYS

FIGURE 2-3 LOWER KEYS

As depicted in Figure 2-4, the alternative evaluation model has three levels. The first lists the principle objective decided by the decision makers, which is to maximize the benefit of the wastewater management alternative. The second level lists a series of issues considered important to address, such as minimizing cost while maximizing ease of implementation, environmental benefits, secondary impacts, and reliability. The third level lists performance criteria, which measures how well an alternative meets the principle objective (maximizing the benefit of the wastewater management alternative). The combined score (represented in parentheses in Figure 2-4) is the importance given to each criterion by the stakeholder groups. As Figure 2-4 shows, the highest score demonstrates that the environmental performance criterion is most important, followed by minimizing costs, and maximizing reliability.

The results of this model were used to recommend the most appropriate alternatives for implementation in Monroe County. These alternatives are also presented in this PEA as proposed alternatives for FEMA funding, and for evaluation under NEPA. The alternatives discussed in this document support established Federal, State, and county objectives by presenting and evaluating alternate methods of wastewater collection and disposal.

As part of the MCSWMP development, Monroe County also implemented a decision-model for selecting sites for the proposed projects. The siting models focused on Maximizing Public Acceptance, Minimizing Cost, Maximizing Beneficial Land Use Characteristics, and Minimizing Environmental Impacts as a framework for selecting the most appropriate sites. Similar to the alternatives development model described above, stakeholders and the SWMP TAC developed measures to evaluate and weigh the framework criteria. Using this model, 42 sites were identified as having the potential to accommodate community and regional WWTPs (Monroe County, 2000a). While site selection is critical to determining site-specific impacts, and thus would be evaluated in the SER, specific sites are not discussed in this PEA because the scope is much broader and is not area-specific by design. The SER would detail the site selection process undertaken by Monroe County and the project applicants, and would provide a site-specific analysis of impacts.

2.3 ALTERNATIVES EVALUATED

This section describes a range of projects related to wastewater management methods and upgrades and explains the proposed alternative actions as well as a brief description of other alternatives that were identified but eliminated from further consideration. The potential environmental impacts of each alternative are described in Section 3. It should be noted that funding may be specific to individual situations and include several funding sources. Projects are described independent of the source or amount of funding.

FIGURE 2-4 DECISION-MAKING MODEL

2.3.1 Alternative 1 – No Action Alternative

FEMA would not provide funds to the project applicants for wastewater management improvements. The county is presently pursuing several State and Federal sources of funding to finance the large capital costs associated with improving their wastewater treatment systems to meet the compliance requirements established by the State of Florida for treatment standards by 2010. FCAA or Islamorada would not have the benefit of FEMA assistance under the No Action Alternative. Communities currently utilizing on-site systems, such as cesspools and septic systems, to manage wastes would have to construct either community or regional WWTPs or on-site wastewater nutrient reduction systems to effectively manage waste nutrients to levels that meet the Florida Statutory Treatment Standards of 2010.

2.3.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

The project applicant, with FEMA grant funds, would construct a new community or regional WWTP or perform facility upgrades to existing systems at selected locations in the Lower, Middle, and Upper Keys (refer to Figures 2-1, 2-2, and 2-3). The project applicants would be responsible for the construction and oversight of these facilities, with compliance monitoring performed by FDEP. Specific details on the roles and responsibilities of the project applicant with respect to design, construction, post-construction, maintenance and operation activities would be described at the site-specific SER level.

New construction of community and regional WWTPs would be targeted in densely populated areas, where the installation of central sewers would eliminate a high number of declining and inadequate on-site wastewater treatment methods such as septic tanks and cesspools. As the population of a community grows, and thus the number of citizens serviced by the community WWTP increases, established community plants may be consolidated into larger regional plants to maintain cost-effectiveness. However, community systems may remain independent if the service area is isolated and not in proximity to a regional plant, thus rendering consolidation cost-prohibitive. Most likely, community WWTPs in the Lower Keys would remain independent, while consolidation of community plants in the Upper and Middle Keys would occur steadily over time as populations increase. All proposed regional WWTPs would be expandable to accommodate higher quantities of wastewater as needed. Capacity expansions to existing WWTPs as well as treatment level upgrades may also occur under this alternative (Monroe County, 2000a).

Flow projections for the 10-year planning horizon (to 2008) were determined from Rate of Growth Ordinance (ROGO) allocations (by geographic distribution), estimated future ROGO allocations, and the number of future units in each area that have development potential and were vested or exempt from ROGO. The total estimated increase in residential wastewater flows in Monroe County for the 10-year planning period is 9%. Increases in non-residential growth were estimated by assuming commercial development under the Commercial ROGO, which for a 10-year period equals 3% (Monroe County, 2000a). (See Section 3.10, Land Use and Planning, for more information on ROGO and community growth).

The WWTP design, size, location, and construction methods would be identified and studied in the respective SERs. In general, WWTP acreage for the average regional WWTP in Monroe County is about 3 acres, while community and interim community WWTPs would use smaller

sites. The construction time for a WWTP in the Keys has been estimated to be about 18 months (Teague, Pers. Comm., 2001). Regional facilities would process 0.5 mgd to 6.0 mgd of effluent and community facilities would process about .004 mgd to 0.5 mgd. Avoidance of sensitive locations (such as residential or natural areas) would be preferred when conducting site selection, however, available land in the Keys is limited and siting may occur within these areas due to lack of options. As a requirement of NEPA, FEMA's implementing regulations with respect to NEPA, and other applicable Federal, State, and local environmental regulations, appropriate mitigation measures to reduce the adverse effects associated with sensitive locations would be implemented.

Specific details on the nature, extent, and duration of construction activities associated with WWTPs would be further developed in SERs. The WWTP construction would typically require the installation of treatment tanks, in-ground and aboveground pipes, pumping stations, and sand or fabric filtration facilities. Project activities would also likely include the construction of storage facilities for maintenance equipment, treatment chemicals, and other operations materials; as well as, administrative buildings, parking lots, and paved access points. For WWTP projects that would replace community-wide, existing on-site septic systems and cesspools, construction activities would likely include the removal of septic systems, excavation and disposal of fill, and new sewer connections. WWTP construction would be conducted pursuant to applicable facility planning regulations at the State and county level. It is expected that coordination between the Monroe County Building Department, Public Works, and City Engineers, among other parties, would be required to ensure that the WWTP's structural and mechanical integrity meet current code, and to ensure that permits relating to siting, planning, design, and operation are obtained, and any conditions to those permits are met. Appendix E provides a summary of potentially required permits.

Under this alternative, the disposal of solid waste, such as sludge and septic waste, would remain consistent with present practice in the Keys. Most wastewater sludge and septic waste generated in the Keys is currently hauled to one of three transfer facilities located on Cudjoe Key, Long Key, and Key Largo. From these transfer stations, the sludge is hauled to a regional wastewater treatment facility in Miami-Dade County for treatment. The Key West WWTP dewaterers partially stabilized secondary solids, which are disposed via a private hauler at an agricultural land application site near Okeechobee, Florida. Because the solids are only partially stabilized, they are incorporated into the soil the same day they are applied to meet FDEP **vector attraction reduction** requirements.

Plants with capacities of less than 100,000 gallons per day (gpd) would temporarily store decanted sludge in an aerated holding tank and haul the liquid sludge to the Monroe County Solid Waste Transfer Station. Plants with capacities of 100,000 gpd or more would process their solids via **belt filter press dewatering, Class B lime stabilization**, and truck hauling of dewatered cake to a remote agricultural land application site.

2.3.2.1 Wastewater Treatment Plant Collection Options:

2.3.2.1.1 Collection Option 1 – Vacuum Pumping

A vacuum sewer system consists of one or more vacuum stations, collection system piping, and vacuum sewer services. Vacuum stations provide both vacuum pumping to draw wastewater to the station, and discharge pumping to pump wastewater through a pressure force main to a

WWTP. Vacuum valves regulate the entry of wastewater and air into the collection system piping. Vacuum stations are usually concrete block buildings on concrete foundations with plan dimensions of 25 feet by 30 feet. Part of the structure is constructed below grade to accommodate entry of the vacuum sewer, and slope requirements (to allow vacuum function) often require grade control and excavation to a somewhat greater depth. A typical residential vacuum sewer system consists of a gravity line from one or more structures to a 30-gallon holding tank equipped with a vacuum line. Air enters the system behind the wastewater. This air is necessary to drive wastewater in the line to the vacuum station. As a benefit, this air provides some aeration of wastewater as it passes through the vacuum collection system. This eliminates anaerobic conditions and associated odor and corrosion problems. The collection tank receives the air and sewage transported by the collection piping. Construction activities associated with the implementation of the vacuum pumping collection option could include excavation of fill and installation of new sewer lines and/or the removal of existing water pipelines.

2.3.2.1.2 Collection Option 2 – Low-Pressure Grinder Pump Sewer System

Grinder pump systems use a small grinder pump station at each wastewater source (such as a residence or business) and small-diameter, low-pressure sewers for transmission either to lift stations or directly to a WWTP. The grinder pump station accepts the entire wastewater stream from the residence or business and is not used in conjunction with a septic tank. All solids in the waste stream are ground to **slurry** and pumped through pressure sewers. Low-pressure grinder pump systems would typically include the use of either centrifugal grinder pumps or progressive cavity grinder pumps. Centrifugal grinder pumps are generally designed for lower pressure applications and require larger water pipe sizes in comparison to progressive gravity pumps. Construction activities associated with the implementation of the low-pressure grinder pump sewer system could include excavation of fill and installation of new sewer lines and/or the removal of existing water pipe. The installation of gravity grinder pumps at individual residences and other wastewater sources would require the excavation of several cubic feet of soil, along with the establishment of new sewer connections.

2.3.2.2 Wastewater Treatment Plant Effluent Disposal Options:

2.3.2.2.1 Disposal Option 1 – Shallow Injection Wells

Disposal of treated effluent would be via shallow injection well, with the depth and treatment levels depending on the design capacity of the WWTP. As dictated by Florida Administrative Code (F.A.C.) 99-395, shallow injection wells must be at least 90 feet deep with at least 60 feet of the well encased in steel and/or PVC and grouted with cement. Construction of a monitoring well, wellhead facilities, and piping from the treatment plant to the wells is also necessary (Monroe County, 2000a). F.A.C. 99-395 specifies that volumes less than 1 mgd be disposed of through shallow injection wells and volumes greater than 1 mgd be disposed of through deep injection wells (greater than 2,000 feet deep). For the purpose of this study, the wastewater facilities would be handling less than 1 mgd and no deep wells would be used, therefore only shallow wells are considered. Figure 2.5 depicts a typical shallow injection well.

FIGURE 2-5 SHALLOW INJECTION WELL

Permitting Class I and Class V Injection Wells

The underground injection wells under consideration in this PEA would be regulated under the joint EPA/FDEP UIC program that oversees underground injection of waste. The EPA/FDEP UIC program divides underground injection into five classes for regulatory control purposes: Classes I through V. Each class includes wells with similar functions, and construction and operating features so that technical requirements can be applied consistently to the class. The shallow wells would typically be permitted as Class V injection wells.

Class I injection wells are defined as wells that inject fluids beneath the lowermost formation containing, within one quarter mile of the well bore, an underground source of drinking water (USDW). Under F.A.C. 62-528, applicants for Class I injection wells must demonstrate that the hydrogeologic environment is suitable for waste injection and without modifying the ambient water quality of other aquifers overlying the injection zone. Additional requirements of Class I injection wells include casing and cementing to prevent the movement of fluids to maintain the ground water quality in aquifers above the injection zone, exploratory pilot holes, monitoring well, and alternate disposal method for emergency events. Under F.A.C. 62-600.540, Ground Water Disposal by Underground Injection, all facilities using Class I wells discharging domestic effluent into G-IV waters (i.e., non-potable water use, ground water in confined aquifers, which has a total dissolved solids content of 10,000 mg/L or greater such as those in the Keys) must meet secondary treatment and pH limitations. Additional information related to the permitting requirements of Class I injection wells for domestic wastewater is in FDEP's regulations for domestic wastewater facilities (F.A.C. 62-600) and underground injection control (F.A.C. 62-528).

Class V injection wells are typically shallow wells, used to place non-hazardous fluids directly below the land surface. However, Class V wells can be deep, highly sophisticated wells (EPA, 2001a). According to FDEP UIC program implementing regulations, the variety of Class V wells and their uses dictate a variety of construction designs and preclude specific standards for each type of Class V well. However, wells require FDEP permitting and FDEP may apply any of the criteria of Class I wells to the permitting of Class V wells if FDEP determines that without the application of Class I permitting criteria, the Class V well may cause or allow fluids to migrate into a USDW which may cause a violation of drinking water standards.

In addition to the standards promulgated under Sections 62-600 and 62-528 of F.A.C., F.L. 99-395 specifies design standards and effluent water quality standards for Class V wastewater injection wells as follows:

Table 2-1: Quality Standards for Discharged Effluent

	BOD (mg/L)	TSS (mg/L)	TN (mg/L)	TP (mg/L)
Sewage facilities with design capacities greater than 100,000 gpd	5	5	3	1
Sewage facilities with design capacities less than 100,000 gpd	10	10	10	1
On-site sewage treatment and disposal systems	10	10	10	1

2.3.2.2.2 Disposal Option 2 - Wastewater Reuse

Treated wastewater may be reused for various purposes in compliance with FDEP regulations governing wastewater reuse. Present uses of treated effluent in Florida include the irrigation of landscaped areas such as golf courses, parks, highway medians, and residential properties; urban uses such as toilet flushing, car washing, dust control, and decorative fountains; irrigation of edible food crops such as citrus, corn and soybeans; wetlands creation, restoration, and enhancement; recharging ground water; and industrial uses such as plant wash down, processing water, and cooling water purposes.

At present, slow-rate land application of treated wastewater is the principal type of reuse system in Florida. Land application involving public access spray irrigation systems is restricted to plants equal to, or greater than, 100,000 gpd in capacity, and the wastewater must be treated to secondary treatment standards, followed by high-level disinfection. Land application by subsurface application systems can be used for any plant size and has reduced effluent quality requirements and only basic disinfection is required. Because of the nutrient benefits to the land, nitrogen and phosphorus removal are not required for land application systems.

Infrastructure requirements would vary depending on the type of wastewater reuse application. The wastewater reuse option may require the installation of water line systems to convey treated wastewater for use in land, urban, or industrial applications. This disposal option may also involve the use of a trucking system to convey wastewater to application sites. Of the 246 WWTPs in the Keys, only 7 were using some form of reuse in 1998. Subsurface drip irrigation is the only reuse method permitted by FDEP for plants less than 100,000 gpd in capacity, which include 241 of the 246 WWTPs in the planning area. The selection of wastewater reuse as a disposal option would require backup disposal systems or storage. Due to land use restrictions in the Keys, the use of storage ponds, tanks, and surface water disposal is not a viable backup system. In most cases, reuse systems would likely be used in conjunction with injection wells for backup disposal and would comply with the applicable Florida Statutory Treatment Standards. FCAA and/or Islamorada would be responsible for identifying a willing recipient of the treated effluent if this option is selected or used in conjunction with other options.

2.3.3 Alternative 3 – On-Site Treatment Upgrades

Project applicants would use FEMA funds to convert OWTS, such as cesspools and septic tanks with drainfields, to OWNRS to improve wastewater management in the Keys (Figure 1-2). OWNRS are engineered treatment systems that, at a minimum, meet BAT treatment standards and require routine maintenance and service from an approved maintenance entity. OWNRS that dispose of 10,000 gpd of wastewater or less are regulated by FDH; OWNRS that process more than 10,000 gpd of wastewater are governed by FDEP and operate under operating permits monitored by the Monroe County Health Department. A biological nitrogen removal system coupled with physical/chemical phosphorus removal system, disinfection (through chlorination or other means), and disposal through either **subsurface drip irrigation** systems (**SDI**) or shallow injection wells are proposed under this alternative. Under this alternative, a “cluster system” would be designed such that multiple homes would use one OWNRS system.

An OWNRS system could vary in required land area based on establishment flow and whether or not the treated effluent is disposed of using SDI or an injection well (Briggs, Pers. Comm., 2001). An OWNRS system utilizing SDI generally requires, at a minimum, 273 square feet for a dwelling unit under 2,250 square feet. Accordingly, clustered OWNRS would require much more land area for SDI disposal. Alternatively, an OWNRS system would discharge effluent to a shallow injection well (i.e., 90-foot well depth with a cement grouted 60-foot casing). Although SDI has been used in Monroe County, it may not be feasible at all sites due to land area and topsoil requirements. It should be noted that of the households that received funding from the Cesspit Identification and Elimination Grant Program (CIEGP), none chose to install SDI systems. Additional details on CIEGP are in Section 3.6.3.2.1.

Construction activities associated with the conversion of septic tanks to OWNRS may require the excavation, removal, and disposal of existing septic tanks and removal of brick, stone, or block that previously lined seepage areas. The installation of an OWNRS would likely include the placement of new tanks and treatment units on vacant land in the area. For OWNRS employing SDI systems, construction activities would include the excavation of soil, placement of irrigation pipe, replacement of soil, and revegetation. As described in MCSWMP, OWNRS can range in size from those serving one home to a centralized OWNRS that serves a large number of homes (Monroe County, 2000a). [Note: Most homes in the Keys have at least two bedrooms. The FDH uses a wastewater generation estimate of 100 gpd per bedroom; therefore, each home would generate at least 200 gpd. Because the FDH standards for OWNRS specifies a maximum of 10,000 gpd, the maximum number of two bedroom homes that could be served is estimated at 50 (FDH, 2001a)]. For OWNRS serving large numbers of homes, construction activities may include the development of storage and staging areas for servicing equipment and operations materials, such as treatment chemicals. Community sewer systems linking residences to OWNRS would likely be constructed, and require excavation and placement of pipeline, and/or grinder pumps at individual residences (Briggs, Pers. Comm., 2001).

2.4 ALTERNATIVES CONSIDERED BUT DISMISSED

Several alternative approaches to wastewater collection and disposal were evaluated towards selecting the most appropriate alternatives to meet the purpose and need for improving wastewater management methods in the Keys. Alternate actions to those proposed under Alternatives 2 and 3, which were considered for detailed evaluation but ultimately dismissed, are

summarized below. It should be noted that all disposal options under Alternative 2 were retained for further detailed study, and for this reason, no disposal options are discussed in this section.

2.4.1 Collection Options under Alternative 2

Conventional gravity sewers are the most widely used method of wastewater collection for residential and other developed areas. Wastewater is transported by gravity from each service connection to a main gravity sewer. The main gravity sewer is sloped to provide a flow velocity adequate to convey solids and minimize settling (generally 2 feet per second). Because of the continuous slope, the depth of gravity sewers increases with distance downstream until the depth becomes too great for economical construction, generally 12 to 14 feet. In the Keys, flat topography, the high water table, and limestone bedrock makes deep excavation impractical. For this reason, conventional gravity sewers were dismissed from further evaluation.

Simplified gravity sewers resulted from a design modification to conventional gravity sewers. Excavation depths are shallower and manholes are smaller in diameter. While their excavation requirement is somewhat less than conventional gravity sewers, these systems would have high excavation and construction costs due to flat terrain, the presence of rock at the surface, and the presence of a high water table in the Keys. This option was also dismissed.

Small diameter gravity sewers (SDGS) use septic tanks at the wastewater source to remove solids and floating materials, such as oil and grease. Effluent from the septic tanks is then discharged to the SDGS. Because solids are removed in the septic tanks, SDGS lines are not designed to transport them. This reduces the velocity and the gradient required. SDGS collection systems require that each connected unit have a septic tank. In order to avoid maintenance problems in the SDGS lines, the septic tanks must be properly maintained, including pumping of septage at regular intervals. The cost of pumping, hauling, treating, and disposing of septage must be included in the overall system operation and maintenance costs. Many of the developed lots in the Keys do not currently have proper septic facilities, and many have none at all. The additional cost of inspecting and/or providing new septic tanks for each connection are an added cost of SDGS that must be considered. The SDGS waste stream is anaerobic and may release hydrogen sulfide upon exposure to air. Hydrogen sulfide can cause odor or corrosion problem in the collection and treatment systems. As with any purely gravity collection system, the flat terrain, shallow depth to rock, and high water table in the Keys would drive construction costs upward. For these reasons, this option was dismissed from further study.

Septic tank effluent pump (STEP) systems are similar to SDGS systems because they use septic tanks at the wastewater source for removal and decomposition of settleable and floating solids. Instead of using SDGS lines to convey septic tank effluent to the WWTP, STEP systems use small STEP stations and pressure sewers. Like SDGS systems, STEP systems have the disadvantage of utilizing numerous septic tanks that must be first inspected or provided and then regularly maintained. Pumping, hauling, treatment, and disposal of septage must be included in the operation and maintenance costs for STEP systems. Another disadvantage of STEP systems is the large number of pumps in the system that must be maintained. This option was dismissed from further study.

2.4.2 On-site Treatment Options under Alternative 3

Conventional OWTS consist of a septic tank and a subsurface wastewater infiltration system, or drainfield, and rely on naturally occurring soils to provide wastewater treatment. The drainfield and unsaturated underlying soils are the most critical components of the conventional OWTS and provide most of the treatment. The problem with installing OWTS in the Keys is that very little or no natural soils exists over the ancient coral/limestone rock, and soil must be imported to construct these systems. The limited soils in the Keys thus reduce the treatment effectiveness of these systems, especially for nutrients. Since a majority of the present water quality issues stem from these types of on-site systems, they do not meet the purpose and need and were dismissed from further study.

ATUs, small aerobic biological treatment systems, are essentially miniature WWTPs, which function similarly to centralized wastewater treatment facilities. Effluent from these systems is discharged either to a drainfield or to a mineral aggregate filter, and then to a shallow injection well drilled to a depth of 90 feet. To meet the Florida Statutory Treatment Standards, an anoxic biofilter (ABF) or an internal recycle loop for nutrient reduction, and a phosphorus removal system would need to be designed and added to the ATU. In many cases, the cost and additional land requirements for these components make implementation impractical. Therefore, this option was dismissed from further study.

Cesspools consist of a large excavation in the ground lined with brick, stone, or concrete block that allow raw wastewater to seep into the natural rock or groundwater. Without a significant soil layer, little, if any treatment of the wastewater occurs in the cesspool, especially if it intercepts groundwater. Pollutant removal is very limited, and nutrient levels approaching those of raw wastewater are being discharged to groundwater. Cesspools, like septic systems, are a contributor to water quality degradation in the Keys waters, and therefore, were dismissed from further consideration because they would likely worsen the water quality problem.

3.1 TOPOGRAPHY, SOILS, AND GEOLOGY

3.1.1 Topography

3.1.1.1 Affected Environment

The Keys are a chain of low-lying islands off the southern tip of Florida, extending southwest from near Miami to Key West (Figure 1-1). The Keys are flanked by the Gulf of Mexico to the north and west and the Atlantic Ocean to the south and east. As generally thought, Key Largo is the most northerly island and Key West the most westerly; the distance from Key Largo to Key West is about 110 miles, and the total area of the islands is about 66,000 acres.

The Keys are subdivided into the Upper Keys and Lower Keys. The Upper Keys extend from Upper Matecumbe Key to Key Largo, and are termed the coral keys that were probably an active coral reef in recent time. The Lower Keys, extending from Lower Matecumbe Key to Key West, are termed the **oolite** keys because the surface materials consist of oolites, small spherical grains of calcium carbonate deposited in shoals after coralline islands were leveled by wave erosion at times of higher sea levels. (It should be noted that topographic data distinguish between upper and lower keys, which includes the area referred to as the middle keys in other areas of this document. A middle keys division is not made with respect to references used in developing this section.)

The Upper Keys (coral keys) have a denuded surface from which the original coral has been completely removed. The surface has some considerable local relief and in places has the ragged, irregular appearance of **microkarst**. Local accumulations of residual soils also exist. The highest elevations in the coral keys are about 16 to 18 feet above mean sea level, on Key Largo and Windley Key. The lower parts of the Upper Keys have a smoother surface that appears to have resulted from marine erosion (White, 1970). Near the edges of the relict coral reef, the surface slopes gently down to the present shore, where it is being cut back by wave splash in the present cycle of shoreline erosion. The shore zone affected by wave splash has an extremely ragged, irregular surface that is honeycombed with solution holes, a few inches to a foot in size.

The Lower Keys (oolite keys) are generally smoother than the coral keys and of lower elevation than the coral keys. Typically the surface is flat and smooth in the center of an island and slopes gently downward near the shore. There is little if any residual soil in the Lower Keys. It appears that the Lower Keys were leveled by the sea when sea level was about 4 to 5 feet higher than at present.

Natural vegetation occurs mainly in tropical hammocks at higher elevations and in mangrove swamps in low-lying areas and along shorelines. About half the area of the Keys is covered by mangrove swamps. In the early 20th century some of the islands were developed for bananas, vegetables, and citrus crops; however, following a hurricane in 1935, crop production ceased and no land in the Keys is currently classed as agricultural (Hurt et al., 1995).

SECTION THREE **Affected Environment and Environmental Consequences**

Topography, Soils, and Geology

Offshore of the Keys on the Atlantic side, the Florida Current flows northward parallel to and east of the Keys and east of the 2-5 mile shelf that supports the growth of modern corals along its outer margins (Halley et al., 1997) (Figure 3-1). Landward of this reef tract is White Bank, a shallow sand shoal studded with patch reefs, and Hawk Channel, an inner shelf lagoon 18-24 feet deep. Just seaward of the Keys, bare limestone equivalent to that exposed in the Keys extends nearly 1 mile offshore. Coral reefs, because they grow at or close to sea level, act as natural breakwaters parallel to the chain of the Keys. As such, they tend to moderate the erosive potential of wave action on the islands of the Keys. Section 3.3.1.2.2 provides a more detailed discussion of the active coral reefs.

Florida Bay, an arm of the Gulf of Mexico, lies northwesterly of the Keys. Florida Bay is a shallow lagoon (average depth about 4 feet) characterized by mangrove-covered mud and peat islands, mudbanks, and shallow marine basins. These mudbanks, islands, and basins are underlain by Pleistocene age limestone equivalent to the limestones that form the Keys (Halley et al., 1997).

3.1.1.2 *Environmental Consequences*

The effects on topography are similar across all of the alternatives. Topographic impacts appear to be limited to temporary surficial disturbances during construction of sewers, treatment plants, and clustered OWNRS. Grading requirements (if any) would permanently change the surficial topographic elevation of the project area, but this impact is minor because it would not significantly alter the flat surface topography of the Keys. Additional details on effects on topography as a result of construction activities would be in the project-specific SER.

It has been suggested that unless the nutrient problem is resolved, further damage to coral reefs will result in greater wave erosion during storms, resulting in major effects on the Keys' topography. As noted by Kruczynski (1999), coral habitats are exhibiting declines in health, but there are no definitive studies on the geographic extent of the impact of anthropogenic nutrients. A variety of diseases that cause coral decline have been reported worldwide from pristine as well as polluted areas (Kruczynski, 1999) and the impacts of nutrient enrichment to coral reefs are not always clear cut or devastating to the coral community. Thus, it is speculative to relate the proposed alternatives to possible, minor, adverse future effects of wave erosion on topography of the Keys. Overall, surficial effects to topography via construction would occur, but long-term effects on topography are unlikely.

3.1.2 Soils

3.1.2.1 *Affected Environment*

The following brief description of soils is adapted mainly from Soil Survey of Monroe County, Keys Area, Florida (Hurt et al., 1995). In general, the soils are sparse and thin and confined largely to hammocks in the higher parts of islands and mangrove swamps in the lower lying areas. About 76% of the total area is mapped in seven soil units; four of these making up 46% of the area are classed as muck, and 35% of the total area represents urban land complexes, rock outcrop complexes and open water (Hurt et al., 1995). The thickness of the soils is generally quoted as less than 10 inches, although some units have maximum depths of up to 82 inches (Hurt et al., 1995).

SECTION THREE **Affected Environment and Environmental Consequences**

Topography, Soils, and Geology

FIGURE 3-1: TIDAL FLOW

SECTION THREE **Affected Environment and Environmental Consequences**

Topography, Soils, and Geology

Of special interest is the fact that in urban developments, totaling 21% of the total area, the land has been largely filled with crushed limestone excavated in constructing canals and spread over the natural surface. Typically the fill material consists of 32 inches of gravelly sand underlain by 40 inches of marl (Hurt et al., 1995).

According to the Soil Survey, there are no prime farmland soils in Monroe County; therefore, the requirement to comply with the Farmland Protection Policy Act is not triggered. Specific soil types at the designated project site would be described in the individual SERs.

3.1.2.2 *Environmental Consequences*

The effects related to all alternatives are similar. Soils would be disturbed during the construction processes and implementation of appropriate **best management practices (BMPs)** and development of an Erosion and Sedimentation Plan should occur prior to and during construction to protect area water bodies and stormwater canals. Applying BMPs and appropriate erosion mitigation (such as use of silt fences) would limit soils effects on temporary disturbances during construction of sewers, treatment plants, and clustered OWNRS under the various alternatives considered.

3.1.3 *Geology*

3.1.3.1 *Affected Environment*

The Keys occupy the southernmost part of the Florida Platform, a 15,000-foot-thick sequence of carbonate and evaporate sediments with relatively minor amounts of fine-grained siltstones and shales. As shown by the submarine topography on Figure 3-2, the Florida Platform, delineated by the minus 330-foot contour, is submerged beneath the Gulf of Mexico, and the coral reef of the Keys approximately define its southern margin. Seaward of the Platform, the continental slope declines sharply to depths of 2,640 feet or more in the Straits of Florida and to nearly 10,000 feet in the Gulf of Mexico. As shown on Figure 3-3, the strata that make up the Floridan Aquifer system are essentially flat lying beneath the Platform but dip seaward beneath the Atlantic continental slope.

The numerous geological formations have been grouped into two principal aquifer systems, the Floridan Aquifer System, comprising water-bearing carbonates (Paleocene through Miocene age), and the Biscayne Aquifer (Pleistocene age), which underlies 4,000 square miles of South Florida. In this report, the Pleistocene age deposits in the Florida Keys are termed the Upper Water-Bearing Zone to avoid confusion with the fresh-water bearing Biscayne Aquifer of the south Florida mainland. The various geologic strata have been subdivided into formations and the stratigraphic terminology used by the U.S. Geological Survey (USGS) is followed herein (USGS, 1990).

SECTION THREE **Affected Environment and Environmental Consequences**

Topography, Soils, and Geology

INSERT FIGURE 3-2: SUBMARINE TOPOGRAPHY

SECTION THREE **Affected Environment and Environmental Consequences**

Topography, Soils, and Geology

INSERT FIGURE 3-3: FLORIDAN AQUIFER

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Topography, Soils, and Geology

3.1.3.1.1 Upper Water-Bearing Zone

The Upper Water-Bearing Zone is the principal supply of fresh water throughout South Florida and the Keys are supplied with fresh water by a pipeline from a mainland well field. The Biscayne Aquifer is highly permeable and its groundwater is under unconfined conditions (in **hydraulic communication** with the atmosphere). In the Keys, the water of the Upper Water-Bearing Zone is generally saline, although on the larger islands, such as Key West, thin fresh-water lenses replenished by rainfall recharge float on the denser underlying saline water. Such fresh water lenses provided small water supplies during the early development of the Keys, but are inadequate to supply the present population. Saline groundwater is used in at least one location (Ocean Reef Club on Key Largo) as input to a reverse osmosis desalination system.

Throughout the extent of the Biscayne Aquifer, it is separated from the deeper Floridan Aquifer System by about 1,000 feet of low-**permeability**, clayey deposits (termed the Upper Confining Unit) that effectively isolate the fresh waters of the Biscayne from the saline water in the Keys' Floridan Aquifer System.

In South Florida, the Biscayne Aquifer supplies essentially all the fresh municipal and irrigation water supply systems, and together with the Floridan Aquifer System supplies saline water for a variety of uses including industry, input to desalination systems, and cooling. Particular interest in recent decades has focused on the deep saline zones of the Floridan Aquifer System as receptors of municipal and industrial wastewaters.

The Biscayne Aquifer of mainland South Florida is generally unconfined and can become degraded by surface contaminant sources. Numerous incidents of localized contamination by petroleum products, commercial solvents, and toxic metals have been recorded; however, the aquifer continues to serve as the main source of potable water and irrigation supply throughout South Florida. In the Keys, the water of the Upper Water-Bearing Zone ranges from brackish to saline and therefore, is little used for potable supply; however, the widespread use of OWTS throughout the Keys has led to extensive nutrient and pathogen contamination as described in Section 3.2, Water Resources and Water Quality.

The Upper Water-Bearing Zone comprises the Pleistocene carbonate rocks that underlie the Keys. In the Keys, these rocks are subdivided into the Key Largo Limestone and Miami Oolite on the basis of their **lithologic** character. The Lower Keys Miami Oolite consists of well-sorted oolite grains with varying amounts of coral, echinoid, mollusk and other skeletal material and some quartz sand (Halley et al., 1997). The Miami Oolite is 9-15 feet thick and was deposited on marine banks and bars. The Key Largo Limestone of the Upper Keys, in contrast, consists of coral remains, interbedded **calcareous** sands, and thin beds of quartz sand. The thickness of the Key Largo Limestone varies but 200 feet was cored at Big Pine Key. At the south end of Big Pine Key, the Miami Oolite grades laterally into the Key Largo Limestone, and elsewhere the Miami Oolite overlies the Key Largo Limestone.

Because of the saline character of the groundwater of the Upper Water-Bearing Zone, there has been little testing of its hydraulic characteristics. However, Halley et al. (1997) estimate the **hydraulic conductivity** of the Miami Oolite to be about 120 meters per day, and of the Key Largo Limestone to be about 1,400 meters per day.

SECTION THREE **Affected Environment and Environmental Consequences**

Topography, Soils, and Geology

3.1.3.1.2 Floridan Aquifer System

The Floridan Aquifer System underlies all of Florida and parts of Georgia, South Carolina, Alabama, and Mississippi. The Floridan Aquifer thickens southward from about 2,000 feet in northern Florida to more than 3,000 feet in southernmost Florida (Figure 3-3). In South Florida and the Keys, the Floridan Aquifer System contains saline water and is not used for water supplies except for industrial cooling and similar uses.

There has been little exploration of the Floridan Aquifer System in the Keys, so what information is available is based on regional extrapolation summarized in USGS Hydrologic Atlas 730-G (USGS, 1990). The Floridan Aquifer System thickness ranges from 2,600 feet at the north end of Key Largo to 3,400 feet near Key West. The Floridan Aquifer System consists of a thick sequence of carbonate rocks, principally limestones and dolomites, mostly of Paleocene to early Miocene age, that are hydraulically connected in varying degrees. Although predominantly limestone and dolomite, other rock types including dolomitic limestone, marl (calcareous, clayey deposits), and phosphatic limestones occur within the system. The Floridan Aquifer System is tightly confined throughout South Florida and the Keys, meaning the upper confining unit is generally greater than 100 feet thick and is unbreached (USGS, 1990). The **hydraulic head** is about 40 feet above mean sea level at the eastern of the Keys and less than 40 feet west of Key Largo; these conditions are fairly unchanged from pre-development conditions (USGS, 1990). This is an important consideration because in order to inject wastewater into the Floridan, pumping must be used to overcome this artesian pressure. The Boulder Zone, a highly permeable cavernous zone in the Lower Floridan Aquifer System, extends throughout the Keys and its top ranges from about -2,800 feet at the north end of Key Largo to -3,300 feet near Key West (Figure 3-4).

The Boulder Zone was first recognized by oil-well drillers in Collier County, Florida, where several commercial oil fields were developed in the early 1940s (Meyer, 1989). The term “Boulder Zone” is a misnomer as this zone is massive, extensively cavernous and fractured dolomite (Miller, 1986). The caverns and fractures result in slow drilling and rough bit action similar to that with drilling through boulders. This behavior gave rise to the misnomer “Boulder Zone,” first applied to the cavernous dolomite by drillers and subsequently adopted by Kohout (1965) and later authors. Miller (1986) further observes that the “Boulder Zone” has no stratigraphic significance, but rather represents a widespread zone of paleokarst in South Florida due to solution of the dolomite at a time when the rocks were close to land surface, above the water table. Subsequent vertical geological movement has carried the paleokarst zone to its present depths of about 2,500 to 3,500 feet.

In 1965, F.A. Kohout of the USGS (Kohout, 1965) proposed a conceptual model for regional flow in the Floridan Aquifer in south Florida. This conceptual model was summarized together with post-1965 substantiating field evidence by Meyer (1989).

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Topography, Soils, and Geology

INSERT FIGURE 3-4: BOULDER ZONE

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Topography, Soils, and Geology

Figure 3-5, adapted from Meyer 1989, shows the essential features of groundwater circulation in south Florida as follows: (1) cool sea water flows inland from the Straits of Florida through the Boulder Zone and other permeable strata in the Lower Floridan Aquifer (upper and middle dolostones); the inflowing sea water is warmed by geothermal heat as it moves inland, becoming less dense as the temperature increases; (2) the lighter, warmer sea water migrates upward through confining units above the lower Floridan Aquifer into the lower part of the upper Floridan Aquifer where it mixes with fresher water recharged from the land surface; (3) the blend, somewhat less saline than sea water, then flows seaward to discharge points along the continental slope on all sides of the Florida Peninsula.

The key features of the circulating system (Figure 3-5) have been substantiated by field data, including stratigraphy, carbon-14 dating of water of the Boulder Zone and upper Floridan Aquifer, uranium isotope ratios in the water of the Boulder Zone, groundwater temperatures, and hydraulic head data. On the key point of upwelling of the warm saline water from the Boulder Zone, Meyer (1989) summarizes temperature and salinity data from several locations on the west coast of Florida near Ft. Myers, and along a structural feature near the east coast about 20 miles inland from St. Lucie Inlet. The locations of these temperature anomalies are shown on Figure 3-2 of this report, which also shows lines of equal temperature of water of the lower Floridan Aquifer and submarine topography off south Florida.

Because the salinity and temperature of the water in the Boulder Zone are similar to those of modern seawater, the zone is thought to be connected to the Atlantic Ocean, possibly about 25 miles east of Miami where the sea floor is almost 2,800 feet deep along the Straits of Florida (USGS, 1990; Singh and Sproul, 1980; Hickey, 1984).

3.1.3.2 Environmental Consequences

3.1.3.2.1 Alternative 1 – No Action Alternative

The project applicant would not receive FEMA funding to help meet Florida Statutory Treatment Standards by the year 2010. The construction of WWTPs, clustered OWNRS, and other wastewater management activities would likely be delayed until adequate funding becomes available.

Effects on geology related to the construction of WWTPs and clustered OWNRS focus on the use of injection wells to dispose of treated wastewater effluent and are further described in Sections 3.1.3.2.2 and 3.1.3.2.3. Impacts relating to the use of a grinder pump or vacuum pump system for collection, and water reuse, as a disposal option would result in minor, temporary impacts relative to geology.

3.1.3.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

Aside from potential impacts related to the use of injection wells, the construction of a WWTP is not expected to result in adverse effects on geology. The environmental consequences to the geologic environment with shallow injection well use are expected to be limited to the effects of injection of relatively fresh effluent into brackish to saline water aquifers, which could affect the rate of limestone solution.

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Topography, Soils, and Geology

INSERT FIGURE 3-5: CIRCULATION

Shallow wells in the context of wastewater disposal in the Keys refers to wells that are at least 90 feet deep with at least 60 feet of the well encased in steel and/or PVC and grouted with cement. Injection of relatively fresh effluent into a unconfined, brackish to saline water aquifer could conceivably increase the rate of limestone dissolution, resulting in enlargement of voids and development of sinkholes. Carbonate rocks are readily dissolved where they are exposed at land surface or overlain by soil zones. Precipitation absorbs some carbon dioxide, sulfur oxides, and nitrogen oxides from the atmosphere as it falls, and from soil organic matter as it percolates down to the water table, thus forming weak carbonic, sulfuric, and nitric acids. This acidic water dissolves carbonate rocks, initially by enlarging pre-existing openings, such as pores and fractures in the rock. These small solution openings become larger as more acidic water moves through the rock; eventually the openings may be tens of feet in diameter. The end result of dissolution of carbonate rocks is a type of terrain called “karst,” which is characterized by caves, sinkholes and other solution openings, and by interconnected underground drainage systems. The acids that cause solution are depleted, or buffered, in reactions with the carbonate rocks, thus the most vigorous solution generally occurs above or near the water table. Deeply buried solution zones, such as the Boulder Zone, generally represent ancient solution activity, called “paleokarst,” at a time when the rocks were close to land surface.

In mainland Florida, such sinkhole development, especially in areas of declining water tables, has been a severe engineering problem. Sinkholes can result in the collapse of the land surface, damaging roads and building foundations, and posing public safety risks among other adverse impacts. However, in the Keys, the water table is generally within five feet of the land surface and water tables have not been declining. If disposal of relatively fresh wastewater and effluent from OWTS and through disposal wells has resulted in accelerated dissolution, the effects have not yet been observed as an engineering issue.

To mitigate the potential effects of limestone dissolution on shallow well design and function, appropriate geotechnical studies would be conducted by the applicant prior to design and construction to adequately characterize the geological and geotechnical environment. The SER would incorporate the data, results, and design measures as appropriate to fully discuss effects on geology. However, based on present observations, accelerated oolite and limestone dissolution may not occur, though engineering design should take adequate precaution against the possibility.

3.1.3.2.3 Alternative 3 – On-Site Treatment Upgrades

Aside from potential impacts related to the use of injection wells, the construction of clustered OWNRS is not expected to result in adverse effects on geology. For disposing of treated effluent, clustered OWNRS may employ either SDI or shallow injection wells. As described in Section 3.1.3.2.2, if disposal of relatively fresh wastewater and effluent from existing on-site systems through shallow injection wells has resulted in accelerated limestone dissolution, the effect has not been observed as an engineering issue in this case. To mitigate the potential effects of limestone solution OWNRS design and function, appropriate geotechnical studies would be conducted by the applicant prior to design and construction to adequately characterize the geological and geotechnical environment.

3.2 WATER RESOURCES AND WATER QUALITY

3.2.1 Regulatory Setting

With its diverse marine ecosystem, natural beauty, and extensive and lucrative recreational opportunities, the Keys constitute an important part of Florida's tourist industry and a significant part of the nation's collective natural resources. Much of the Keys economic and natural resource value relies on the maintenance of high water quality. In order to protect the Keys' environmental health and water quality, a number of laws, standards, and regulations have been promulgated by Federal, State, and local agencies including the EPA, NOAA, USACE, FDEP, FDH, FCAA, South Florida Water Management District, FKNMS, and Monroe County. The marine environment in the Keys is also managed through the FKNMS whose geographic area covers the entire stretch of the Keys, and whose technical advisory and steering committees include representatives from the aforementioned organizations along with the USFWS, Everglades National Park, Florida Keys Environmental Fund, and the Cities of Key Colony Beach, Layton, and Key West.

A number of Federal, State, and local laws and regulations govern water quality issues in the Keys, including the Florida Keys National Marine Sanctuary and Protection Act, CWA, RCRA, and the EPA's Ocean Discharge, Gulf of Mexico, UIC, and Ocean Dumping Programs, among others.

The waters surrounding the Keys have been declared as "Outstanding Florida Waters" (OFW) by the State of Florida (FDEP, 1985). "Special Waters" and OFWs include 39 of Florida's 1700 rivers, several lakes and lake chains, several estuarine areas, and the Keys. By regulation, input of materials that could be considered pollutants to open surface waters cannot exceed the concentration of those materials that naturally occur in water. However, ambient background conditions can change seasonally or at different phases of the tidal cycle. Because of the OFW designation, direct surface water discharges of pollutants have been eliminated, or are being phased out (Kruczynski, 1999).

Proposed activities in OFWs that would normally require a FDEP permit are required to meet the following separate requirements for direct and indirect discharges:

- New direct pollutant discharges must not lower existing ambient water quality.
- New indirect pollutant discharges (discharges to waters that influence OFWs, although not placed directly into an OFW) must not significantly degrade nearby OFWs.

New project activities receiving FDEP permits must also be "clearly in the public interest." Existing legal discharges are "grandfathered" and may continue without any new OFW requirements.

As part of the evaluation of the Keys as OFW, water quality "Hot Spots" were identified. These "Hot Spots" are canals and other confined water bodies that demonstrate signs of eutrophication (i.e., higher levels of BOD, TSS, TN, and **total phosphorus [TP]**) and have been targeted by FDEP as priority areas for water quality management activities. A list of the "Hot Spot" rankings and a map of their locations are included as Appendix C and Figures 2-1, 2-2, and 2-3, respectively.

SECTION THREE **Affected Environment and Environmental Consequences**

Water Resources and Water Quality

In concert with the establishment of the FKNMS, EPA, and FDEP developed the Water Quality Protection Program (WQPP) for the Sanctuary. The purpose of the WQPP is to recommend priority corrective actions and compliance schedule for addressing point and multipoint sources of pollution to restore and maintain the chemical, physical, and biological integrity of the Sanctuary, including restoration and maintenance of a balanced, indigenous population of corals, shellfish, fish, and wildlife, and recreation activities on the water (Florida Keys National Marine Sanctuary and Protection Act).

State of Florida water quality standards are promulgated in Chapter 62-302 F.A.C. Rule 62-302.400 classifies surface waters of the State according to designated uses that include: Class I, Potable Water Supplies; Class II, Shellfish Propagation or Harvesting; Class III, Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife; Class IV, Agricultural Water Supplies; and Class V, Navigation Utility and Industrial Uses. Marine waters in the Keys are classified as Class III Marine Waters and include criteria levels for 89 potential pollutants under Rule 62-302.530.

Both the EPA and NOAA have direct mandates to conduct monitoring in FKNMS. Comprehensive, long-term monitoring program was begun by Florida International University under contract to the EPA as part of the WQPP in 1995. These monitoring efforts include 42 fixed stations throughout the Keys to monitor coral population dynamics, 154 fixed stations from Key Largo to the Dry Tortugas that monitor water quality parameters such as nutrients, salinity, **turbidity**, and **phytoplankton** biomass, and 51 sites throughout the FKNMS to monitor seagrass dynamics (FKNMS, 2001). Some recent results of this monitoring program are presented in Section 3.2.3.1.2 of the PEA.

The Safe Drinking Water Act of 1974, to protect the quality of drinking water in the U.S., promulgates drinking water regulations. This law focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. Florida State regulations classify potable water supplies as Class I under Rule 62-302.400. The Keys' potable water supply is provided by the FCAA from water drawn from wells in the Biscayne Aquifer below a pineland preserve west of Florida City in Dade County, on the mainland.

The South Florida Water Management District (SFWMD) provides flood control protection and water supply protection to residents living and working in cities or on farms within south Florida; and is working to restore and manage ecosystems from the Kissimmee River to the Everglades and Florida Bay. SFWMD issues permits for the construction of water supply wells, as well as environmental resource permits that regulate wetland resources, mangrove alteration, and surface water management in accordance with the Florida Environmental Regulation Act of 1993. SFWMD defers wastewater regulation, including the construction of wastewater injection wells to FDH and FDEP (Leckler, Pers. Comm., 2001).

Of particular relevance to this analysis is F.L. 99-395 that pertains to OSTDSs. Passed by Florida State Legislature in 1999, this law includes specific requirements for all sewage treatment, reuse and disposal facilities, and all OSTDSs in Monroe County. The provisions prohibit any new or expanded discharges into surface waters, and require that existing surface water discharges be eliminated before July 1, 2006. As detailed in Table 2-1 in Section 2.3.2, F.L. 99-395 specifies effluent standards produced by sewage facilities of varying capacity.

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In addition to the State standards, the *Monroe County Year 2010 Comprehensive Plan*, initially adopted in 1993 and amended in 1997, mandates that nutrient loading levels be reduced in the marine ecosystem of the Keys by the year 2010. In 1998, the Florida Governor issued EO 98-309 that charged local and State agencies with coordinating with Monroe County to execute the *Year 2010 Comprehensive Plan* in order to eliminate cesspits, failing septic systems and other substandard on-site sewage systems, and to require that all wastewater discharge be treated to AWT or BAT. Construction of WWTPs and wastewater effluent injection wells are regulated by FDEP for wastewater quantities in excess of 10,000 gpd, and by FDH for quantities below 10,000 gpd.

3.2.2 Groundwater

3.2.2.1 Affected Environment

While large quantities of saline water underlie the Keys, fresh water resources are limited to a few fresh water lenses beneath some of the larger islands of the Lower Keys. The islands of the Upper Keys are generally long and narrow and the groundwater is at best brackish and of little potential utility except as input for desalination systems. In the Lower Keys, some islands are relatively large and underlain by the Miami Oolite, which is favorable for small fresh water to slightly brackish water lenses. Such lenses have been used in the past for domestic water supply and for irrigation and other water uses.

The potable water supply resources used by Monroe County are obtained from wells tapping the Biscayne aquifer in Miami-Dade County, entirely outside of Monroe County's jurisdiction. No new wells have been permitted in the Keys since 1986, which would limit use of underground brackish/saline resources in the Keys as potential potable water resources. The FCAA is the agency that obtains and distributes potable water in the Keys. Since the potable water source for Monroe County is located entirely within Miami-Dade County, aquifer protection related to the FCAA's Florida City Wellfield is accomplished through the provisions of the Miami-Dade County Wellfield Ordinance. In Monroe County, groundwater resource protection and management takes place in the context of intense Federal, State, and private interest in natural systems as evidenced by the extensive amount of protected lands and waters (Monroe County, 1997).

The Key West and Big Pine Key fresh water lenses have been studied and reported on. The Key West lens in 1986 (defined as groundwater of less than 250 mg/L chloride content) averaged about 1.5 meters thick at its center, and was estimated to contain 30 million gallons (Mgal) at the end of the rainy season and 20 Mgal at the end of the dry season (Halley et al., 1997). A Big Pine Key lens (defined as ground water of less than 500 mg/L chloride content) extends down to about 16 feet, and the lens' base corresponds to the base of the high permeability sediments of the Miami Oolite (Halley et al., 1997).

Of greater interest in the Keys is the use of groundwater for waste disposal. It is reported that about 26,000 Keys properties are served by on-site sewage disposal systems, including 18,000 permitted septic tank systems and 7,200 unpermitted systems, presumably largely cesspools. Multifamily dwellings and commercial facilities commonly rely upon package WWTPs, of which there are some 250 permitted (Kruczynski, 1999).

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Affected Environment and Environmental Consequences

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Because of stringent regulatory standards for surface-water discharges, the package plants generally discharge treated effluent through permitted “shallow” Class V injection wells, of which 750 have been permitted in the Keys (Kruczynski, 1999). These shallow Class V wells are required to be 90 feet deep and with a grouted cement casing to 60 feet; thus, they discharge relatively fresh but nutrient rich waters into the Upper Water-Bearing Zone. By virtue of their design, the 26,000 on-site systems also discharge their effluents into the Upper Water-Bearing Zone.

As described in more detail in Section 3.2.2.2.2.2, the deeper Floridan Aquifer has been used for the disposal of treated effluent through deep injection wells in various parts of Florida for more than 40 years with the deep injection well in operation in Broward County in 1959 (Earle and Meyer, 1973; Vecchioli et al., 1979). There are about 120 of these types of deep injection wells in Florida, classified as Class I (FDEP, 2001a). Most of the Class I injection facilities in Florida dispose of non-hazardous, secondary treated effluent from domestic WWTPs. At present, there is one deep injection well used to dispose treated municipal wastewater operating in the Keys. Located in the City of Key West, the deep injection well has been in operation since early September 2001 and replaces an ocean outfall. The deep injection well is used to dispose of treated municipal wastewater, and has average daily flow of 4.0 mgd and maximum capacity of 7.2 mgd (Fernandez, Pers. Comm., 2001).

The EPA (1996) estimates that nutrient loading from the Keys to nearshore marine waters total 2,377 lbs/day of TN and 544 lbs/day of TP. Of these totals, about 80% of TN (1,900 lbs/day) and 56% of TP (305 lbs/day) were attributed to wastewater disposal; the remaining 20% (475 lbs/day) of TN and 44% (239 lbs/day) of TP were allocated to stormwater runoff from the Keys. These loading estimates assume that all wastewater nutrients, including groundwater sources, reach nearshore marine waters. Of the total loading cited above, 13.5% (321 lbs/day) of TN and 6.6% (36 lbs/day) of TP were attributed to municipal outfall discharges chiefly of the City of Key West, which replaced their ocean outfall with a deep injection well in September 2001. Live aboard boats discharging sewage directly to marine waters account for 3.5% (84.1 lbs/day) of TN loading and 5.5% (30 lbs/day) of TP loading. Deducting the direct nutrient contributions from outfalls, boats, and stormwater runoff results in about 1,497 lbs/day of TN and 239 lbs/day of TP as the groundwater contribution to the total nutrient loading of the nearshore marine waters. These data suggest that nutrient-rich groundwater accounts for about 79% of TN and about 78% of TP loading from the Keys to the nearshore marine waters (EPA, 1996). At present, these numbers may be slightly lower because State waters within the Florida Keys National Marine Sanctuary became designated as a No Discharge Zone for sewage from all vessels in June 2002. Monroe County, 2002). As described in Section 1.4, nutrient levels in these nearshore marine waters are also influenced by external sources, such as the Gulf of Mexico and Florida Bay.

Long, continued waste disposal into the Upper Water-Bearing Zone has led to major groundwater quality changes in the developed areas. While the wastewater is of lower salinity than that of the natural groundwater, the wastewater is enriched in the nutrients nitrogen and phosphorous, as well as **fecal coliform** bacteria, and it is oxygen-depleted. As groundwater is minimally used in the Keys, this groundwater quality degradation has been of little direct concern. However, the Upper Water-Bearing Zone is in direct communication with the nearshore marine waters, and the degraded groundwater can discharge into the marine environment within hours to days. Because of the high groundwater salinity in the Upper-Water Bearing Zone, there has been little testing of its hydraulic characteristics. However, Halley et al. (1997) estimate the

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hydraulic conductivity of the Miami Oolite to be about 120 meters per day, and of the Key Largo Limestone to be about 1,400 meters per day. This pattern of rapid groundwater discharge to nearshore marine waters is exacerbated by the 700 or so dead-end canals constructed over the past several decades, for the purposes of providing boat access to residences and dredge material for landfilling. Generally, these canals were excavated to 10 to 20 feet to maximize the amount of material available for landfilling. These deep dead-end canals in residential areas served by on-site sewage disposal systems have the general effect of speeding the groundwater discharge to marine waters. The water quality effects are described Section 3.2.3.

3.2.2.2 Environmental Consequences

3.2.2.2.1 Alternative 1 – No Action Alternative

As described in Section 2.3.1, FEMA funding would not be available for the wastewater management projects, but individual property owners and/or communities would still comply with the Florida Statutory Treatment Standards by 2010.

Disposal of nutrient-rich sewage effluent to the shallow groundwaters of the Keys would be largely ended. Effluent would be disposed of in shallow injection wells. Solid wastes (sludge) from the waste treatment facilities would be disposed of at appropriate licensed disposal sites in mainland Florida.

According to the MCSWMP, areas that are not served by new or upgraded WWTPs would be required to replace existing OWTS with OWNRS that meet Florida Statutory Treatment Standards. New or upgraded OWNRS systems would use either shallow injection wells (90 feet deep) or SDI for treated effluent disposal.

Expected Water Quality Benefits of Meeting Florida Statutory Treatment Standards

Replacing existing cesspools and septic systems with OWNRS systems and centralized WWTPs in compliance with Florida Statutory Treatment Standards would greatly reduce the overall nutrient and pathogen inputs to the shallow groundwater of the Keys, and thus contribute to overall groundwater quality improvements.

As part of preparation of this PEA, an analysis was conducted to estimate the extent of water quality improvements that might be expected by improving wastewater management within an existing service area in the Keys (Appendix D). The analysis focused on a proposal for four small WWTPs in the Village of Islamorada that had average daily flow capacities of 0.534 mgd, 0.062 mgd, 0.186 mgd, and 0.129 mgd, respectively with effluent treated to AWT standards (i.e., 5 mg/L BOD, 5 mg/L TSS, 3 mg/L TN, 1 mg/L TP), (Islamorada, 2001a). The analysis assumes that currently all sewage disposal is by on-site septic systems (i.e., no cesspools/cesspits), and that the wastewater inflow is the average daily flow of the proposed plants (i.e., 0.911 mgd). The assumption that all on-site systems are septic tanks is a conservative estimate of existing nutrient loadings because the existing cesspools typically generate higher nutrient loadings than septic tanks. Additionally, the analysis assumes that raw sewage nutrient concentrations are the same as those estimated in the Big Pine Key Demonstration Project (Ayres Associates, 1998), and that TP is not removed from groundwater by reaction with aquifer limestones. The results of the analysis found that the replacement of existing OWTS (assumed all septic systems) with WWTPs that meet AWT standards result in a 92% reduction in TN input to groundwater (i.e.,

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280 lbs/day decreased to 22.8 lbs/day), and a 86% reduction in TP input to groundwater (50 lbs/day to 7.6 lbs/day). In groundwater transit to discharge to marine waters, negligible TN reduction occurs, and it is assumed that TP is not removed from water by chemical reaction with the aquifer's carbonate rocks. Thus, the benefit of AWT systems in terms of nutrient removal would be in the form of 92% reduction in TN and 86% removal of TP. Please see Appendix D of this PEA for additional details pertaining to the results of this analysis.

It should be noted that the treated effluent would still contain limited nutrients even under conditions that meet the 2010 standards. Similarly, under the most favorable circumstances, low levels of contaminants would still reach the groundwater with leakage from domestic sewers and collection systems and from fugitive stormwater runoff and leakage from stormwater sewers. While the limited nutrients and pathogens would enter the shallow groundwater of the Keys even under after implementation of the alternative, the overall result is a net improvement in groundwater quality when compared to nutrient and pathogen levels prior to alternative implementation. Even with alternative implementation, years to centuries would be required to flush existing contaminants and nutrients from the shallow groundwater. However, with cleanup efforts focused on major problem areas, incremental benefits in the form of improvement in groundwater quality should be observed promptly.

3.2.2.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

This alternative would involve the construction or upgrade of WWTP systems with the assistance of FEMA funding. Effects on groundwater would be similar to those described under the No Action Alternative. The water quality improvements expected under this alternative would be on the order of those described in the No Action Alternative and further outlined in Appendix D (i.e., 92 and 86% reductions in TN and TP loadings, respectively). However, it is difficult to determine the exact extent of these improvements due to a number of unknown variables. These include the length of time it would take to flush out present levels of nutrients and other pollutants presently in the groundwater, local variations of hydrogeologic characteristics, and the extent to which limestone substrates remove phosphorus from injected effluent. It is recommended that the project applicants implement a water quality monitoring program following the installation of a WWTP to assess the resulting changes in nearshore and offshore water quality.

WWTP construction would require several FDEP permits in accordance with F.A.C. Applicable permits for WWTP construction and operation are described in Appendix E.

3.2.2.2.2.1 Collection Options: Vacuum Pumping (Option 1) and Low-Pressure Grinder Pump Sewer System (Option 2)

Assuming proper design and reasonable operating conditions, neither the use of vacuum pumping nor low-pressure grinder pump sewer system would involve significant effects on groundwaters. Establishment of the collection system as part of new treatment plant construction would require the FDEP permits identified in Appendix E.

3.2.2.2.2.2 Disposal Option 1 –Shallow Injection Wells

Most WWTPs in the Keys currently dispose their treated effluent into shallow injection wells (cased 0 to 60 feet, open hole 60-90 feet). The effluent represents recharge to the highly

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permeable Upper Water-Bearing Zone limestones. As further described in Section 2.3.2.2.1, such wells are considered as Class V wells and at plants of less than 100,000 gpd capacity are required to meet BAT limitations (i.e., 10 mg/L BOD, 10 mg/L TSS, 10 mg/L TN, and 1 mg/L TP).

Plants of larger than 100,000-gpd capacity are required to meet more stringent AWT effluent limitations (i.e., 5 mg/L BOD, 5 mg/L TSS, 3 mg/L TN, and 1 mg/L TP).

The application of effluent limitations to injection wells represents a major improvement when compared to cesspools and septic systems. However, even in compliance with the Florida Statutory Treatment Standards, effluent limitations would still allow for some nutrient inputs to shallow groundwater. The expected water quality improvements are described further in Section 3.2.2.2.1.

Present Federal requirements prohibit any injection activity that may endanger USDW (40 CFR Part 144). Similarly, present Federal regulations require all owners and operators of Class V injection wells to provide inventory information to FDEP, the State UIC authority. Construction of new wells or upgrade of existing “shallow” Class V injection wells would require compliance with joint EPA/FDEP UIC regulations and the FDEP-administered permits referenced in Appendix E. As further explained in Section 3.6.4, Public Health, effluent would be disinfected to reduce the health risk of fecal contamination through such techniques as biological treatment and/or chlorination.

3.2.2.2.2.3 *Disposal Option 2 – Wastewater Reuse*

Under present State regulations, effluent reuse is authorized for various purposes of which land application for irrigation is the principal reuse practiced in Florida. However, in the Keys, land application has not been widely used, owing to the absence of agricultural demand and the high cost of effluent reuse due to stringent treatment standards, which is not competitive with the cost of fresh water imported from the mainland via pipeline. Under continuation of present policies and conditions, it is not expected that effluent reuse would significantly affect groundwater in terms of quality or quantity.

The application of treated wastewater is regulated through FDEP. The required permits for this alternative depend on the type of application. The applicable permits are referenced in Appendix E.

3.2.2.2.3 *Alternative 3 – On-Site Treatment Upgrades*

FEMA funding would be used to assist in the conversion of OWTS to clustered OWNRS. New OWNRS would be required to meet BAT standards of 10 mg/L BOD, 10 mg/L TSS, 10 mg/L TN, 1 mg/L TP.

As estimated by Ayres Associates (1998), raw residential wastewaters typically contain 200 to 400 mg/L BOD, 200 to 400 mg/L TSS, 35 to 100 mg/L of TN, and 12 to 18 mg/L of TP. Septic systems typically reduce these levels to average values of 138 mg/L for BOD, 49 for TSS, 45 for TN, and 13 for TP (SSWMP, 1978). Cesspools and cesspits probably offer little reduction in these parameters below the raw-water concentrations. Regulated OWTS and cesspits/cesspools are estimated to account for 50% of the wastewater TN loading and 60% of the TP wastewater loading emanating from the Keys, respectively (Ayres Associates, 1998).

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An OWNRS demonstration project, funded by FDH and EPA, was conducted at Big Pine Key to demonstrate the use and capability of alternative on-site technologies for the Keys (Ayres Associates, 1998). The OWNRS demonstration project consisted of detailed treatment system performance evaluations at a central test facility on Big Pine Key and general field evaluations of alternative on-site systems installed at three individual homes in the Lower Keys. The Big Pine Key Road Prison was selected as the central test facility and the design was set up to allow comparative testing of five on-site wastewater treatment processes simultaneously, under controlled conditions, with a common wastewater source. The loading schedule of the systems was programmed to simulate the diurnal wastewater flow characteristics of a single-family residence, with peaks in the morning and early evening hours (Ayres Associates, 1998).

The following treatment processes were tested to evaluate their potential to reduce organic, solids, and nutrient loading to near-shore waters of the Keys:

1. Conventional septic tank coupled with a recirculating sand filter (RSF) and ABF.
2. Conventional septic tank coupled with SDI in porous media irrigation beds.
3. Fixed Activated Sludge Treatment (FAST), (proprietary).
4. Continuous Feed Cyclic Reactor System (CFCRS), (proprietary).
5. Rotating Biological Contactor (RBC), (proprietary).

Additional unit processes were tested for nitrogen and phosphorus removal as add-ons to the above methods. These included a chemical precipitation unit (CPU), engineered porous media intermittent filter beds with SDI, and a carbon tablet feeder/ABF for de-nitrification.

Table 3-1 below summarizes the nutrient removal levels associated with each treatment process (1-5) as compared to the Florida Statutory Treatment Standards (in italics) for each nutrient.

Table 3-1: Big Pine Key Treatment System Nutrient Removal Rates

System Number	BOD (mg/L)	TSS (mg/L)	TN (mg/L)	TP (mg/L)
	<i>10</i>	<i>10</i>	<i>10</i>	<i>1</i>
1	2.18	2.25	20.76	1.76
2	2.81	4.09	21.15	0.6
3	2.63	4.63	10.97	5.38
4	3.19	6.85	15.46	6.24
5	1.68	5.75	12.52	4.67

In summary, all the systems tested met the BAT limits and AWT limits for BOD and TSS. None of the systems tested met the BAT limit for TN and only one met the TP limit. Ayres Associates (1998) concluded that a combination of unit processes with discharge to an engineered media SDI could reduce TN by 85%, and together with process optimization and/or supplemental carbon addition could produce effluent discharged from the SDI close to the AWT TN limit of 3 mg/L and effluents could meet AWT limits for BOD (5 mg/L), TSS (5 mg/L), and TP (1 mg/L).

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With respect to the environmental consequences to groundwater resources, the upgrading of OWTS to OWNRS standards would reduce contributions of nutrient (TN and TP) and pathogen loadings to groundwaters of the Keys, and thus would be beneficial to that environment. However, after upgrading is completed, years to centuries of flushing of the existing nutrient load from the aquifers would be required before optimal levels of nutrient discharge to nearshore marine waters could be expected. Only long-term observation would answer the question of how long it will take to correct the existing nutrient discharge to nearshore sea waters. Additionally, problems of non-compliance with design standards and operation and maintenance procedures could reduce the potential for water quality improvements. It is recommended that the project applicants implement a water quality monitoring program following the installation of a clustered OWNRS to assess the resulting changes in water quality in nearshore and offshore waters.

The results of field tests reported by Ayres Associates (1998) were highly encouraging regarding the ability of OWNRS to meet the Florida Statutory Treatment Standards of 2010. However, it should be recognized that not all upgraded systems would perform as well as research-style field tests. It is unlikely that all systems would meet design standards, and operation and maintenance procedures are difficult to monitor and enforce. Thus, continued contamination of nutrients at low levels exceeding the OWNRS limits may be expected under Alternative 3. In order to mitigate this potential adverse impact, the project applicant would be required to establish a monitoring, compliance, and enforcement plan to help ensure that clustered OWNRS systems meet Florida Statutory Treatment Standards on a consistent basis.

3.2.3 Inland, Nearshore, and Offshore Waters

3.2.3.1 Affected Environment

The surface water resources of the Keys include: (1) inland ponds, which compose 3,400 acres or 5.2% of the total area of the islands (Hurt et al., 1995); (2) about 700 canals constructed to provide boat access to marinas and residential developments; (3) stormwater runoff to ditches and drainage systems in developed areas; and (4) nearshore marine waters. There are no permanent streams on the Keys as most rainfall evaporates, infiltrates directly into the ground, or runs off as sheet flow to canals or the shoreline. Although the orthophoto maps of Hurt et al. (1995) identify seven features as creeks, these features in all cases are tidal channels connected at both ends to marine waters. Although the inclusion of nearshore marine waters as surface waters of the Keys may seem odd because their outer extent is ill defined, the degradation of the marine environment is the focus of public concern about environmental degradation in the Keys. Although degradation of the marine environment is the focus of public concern, owing to the diffuse nature of stormwater runoff and groundwater discharge to marine waters, little comprehensive data is available on the quantity and quality of surface runoff and groundwater discharge to the marine environment.

3.2.3.1.1 Inland Waters

Degraded water quality within canals throughout the Keys has been documented since the early 1970s. Barada and Partington (1972) concluded that excavating artificial canals causes serious environmental degradation within the canals themselves and in waters adjacent to canals. Deep, narrow, box-cut canals with dead-end configurations gradually accumulate oxygen-demanding and

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toxic sediments and organic wastes, causing low dissolved oxygen, objectionable odors (hydrogen sulfide), and floating sludge that can result in fish kills and undesirable conditions. Eutrophication often occurs in canals with poor circulation and is accelerated by a heavy pollution load, which is related to population density and shoreline length (Barada and Partington, 1972; Kruczynski, 1999).

Studies also indicate that sewage discharged from cesspits and septic tanks are a significant source of nutrients and pathogens to canal waters. A direct connection with septic tank waste disposal and canal waters was shown by a viral tracer study in Key Largo. Tracers added to a domestic septic tank appeared in a canal in 11 hours (Paul et al., 1995a). The rapid hydraulic conductivity of Keys aquifers of wastewater and the influence of tides have been identified as major sources of water quality problems in canals (Kruczynski, 1999). As further evidence of the eutrophication of canal waters, seagrass beds located near the mouths of some degraded canal systems show signs of eutrophication, such as increased **epiphyte** load and **benthic algae** growth.

Canals and other confined water bodies that showed signs of eutrophication during a review of OFW in the Keys were listed as “Hot Spots” (Appendix C; Figures 2-1, 2-2 and 2-3). Three recommendations were made for all higher priority, poorly designed canal systems: install BAT sewage treatment, collect and treat stormwater runoff, and improve canal circulation (Kruczynski, 1999; EPA, 1993a).

3.2.3.1.2 Nearshore and Offshore Marine Waters

The Keys ecosystem has been described as an “open” system because of the high degree of communication between ground, canal, and nearshore and offshore marine waters. The Keys’ nearshore waters are primarily influenced by the Gulf of Mexico, either directly (primarily Lower Keys) or via passage through Florida Bay (primarily Middle Keys). There is a net flow of surface and groundwater flow from the bay-side to the ocean-side of the Keys. A higher mean sea level in Florida Bay than in Hawk Channel provides a “head” that drives net water flow towards Hawk Channel (refer to Figure 3-1). In general, net water transport within Hawk Channel is to the west with an offshore component. Because of this, water passing through the large passes of the Middle Keys flows west and south and has relatively little influence on ocean-side waters of the Upper Keys. Periodically, oceanic waters from the Florida Current can influence lower portions of Hawk Channel depending upon offshore circulation patterns and tides (Monroe County, 2001a).

Water flow through the Keys is primarily tidally driven with the underlying differential sea levels influencing the net transport. Wind events also affect such transport, particularly in winter when northerly winds enhance this net north to south movement and reduce sea levels, exposing shallow banks. The flow velocity (speed of water movement) in the channels is strongly influenced by tidal height differentials (greater during spring tides) as well as wind. Average and extreme flow velocities are important physical factors in determining the nature of marine sediment distribution and the associated benthic communities (Monroe County, 2001a).

Several recent studies have found a connection between fecal contamination and eutrophication of nearshore waters and septic tanks. Lapointe and Clark (1992) found a gradient in nutrients from nearshore to offshore waters with canals having elevated soluble reactive phosphorus (0.3 micromole (μM)) compared to seagrass meadows (0.1 μM), patch reefs (0.05 μM), and offshore reef banks (0.05 μM). The results of the study concluded that the widespread use of septic tanks increases the nutrient contamination of groundwaters that discharge into shallow nearshore waters,

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resulting in coastal eutrophication. In a later study, Lapointe et al. (1994) found that nutrient enrichment from land-based sewage inputs can significantly affect seagrass productivity for considerable distances from shore (3 to 4 miles). Paul et al. (1997) used an active shallow Class V disposal well in the Middle Keys and a simulated injection well in Key Largo to understand the transport and fate of wastewater. In both areas, viral tracers appeared after short periods in marine waters (10 hours and 53 hours for Key Largo and the Middle Keys, respectively).

Szmant and Forrester (1996) measured distribution patterns of nutrients to determine whether nutrients from the Keys may be reaching the outer reef tract. Samples were taken along transects at stations located in tidal passes and canal mouths to about 0.5 km seaward of the outermost reef (Kruczynski 1999; Szmant and Forrester, 1996). In the Upper Keys, water column nitrogen and chlorophyll were elevated near marinas and canals, but returned to **oligotrophic** concentrations within 0.5 km of shore. Phosphorus concentrations were higher at offshore stations and were attributed to upwelling of deep water along the shelf edge at time of sampling (Kruczynski 1999; Szmant and Forrester, 1996). In the Middle Keys, both water column nutrients and chlorophyll concentration were higher than observed in the Upper Keys, and there was a lower gradient of nearshore-offshore waters in comparison to the Upper Keys. Sediment nutrients were also higher, and there were no differences in nutrient concentrations at nearshore and offshore areas. In general, the results of the study found that nutrient pollution emanating from the Keys had greater nearshore effects than offshore effects due to the high level of dilution from currents and tidal movement. Offshore areas in the Middle Keys that had higher nutrient levels than offshore areas in the Upper Keys were attributed to the relatively high nutrient-content of Florida Bay (Kruczynski 1999; Szmant and Forrester, 1996).

In addition to directed scientific research, water quality monitoring has been conducted by Florida International University as part of the WQPP since 1995 as introduced in Section 3.2.1. Of the several water quality parameters that have been monitored, the program has revealed significant trends in TP, nitrate (NO₃), and total organic nitrogen (TON). According to the Fiscal Year 2000 Annual Report, trend analysis showed statistically significant increases in TP for the Tortugas, Marquesas, Lower Keys, and portions of the Middle and Upper Keys over the 5-year sampling period. The trends were identified as linear increases with little seasonality. No TP trends were observed in Florida Bay or in those FKNMS sites most influenced by transport of Florida Bay waters. Concentrations of NO₃ increased over the period with most of the increases occurring in the Shelf, Tortugas, Marquesas, Lower Keys, and Upper Keys. TON decreased over the 5-year sampling period. The monitoring program speculates that regional circulation patterns arising from the Loop and Florida Currents were responsible for the decreases in TON (Jones and Boyer, 2001). It should be noted that several other studies, including Cook (1997) and Rudnick et al. (1999), identify Florida Bay and the Gulf of Mexico as significant contributors of nutrients to the marine waters of the Keys. Additional research is needed to identify the relative contributions of the various sources of water quality degradation in the nearshore and offshore waters of the Keys.

Rainfall in the Keys rapidly flushes nutrients into canals and adjacent nearshore waters (Lapointe and Matzie, 1996). The highest levels of dissolved inorganic nitrogen, soluble reactive phosphorus, and chlorophyll occurred during periods of high winds, low tides, and rain. Low tides allow rapid drainage of nutrient enriched groundwater to adjacent nearshore waters (Kruczynski 1999; Lapointe and Matzie, 1996).

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3.2.3.1.3 Stormwater

Monroe County has a mild, subtropical climate with an average temperature of about 77 degrees Fahrenheit, and seasonal deviation of monthly mean temperatures of only about 10 degrees Fahrenheit. Dominated by the trade winds, the Keys receive about 65% of the average annual 38 inches of rainfall during the wet season from May to October (Monroe County, 1997). Rainfall from this period is augmented by tropical weather systems in various stages of development. Although the Keys do not receive direct impact of tropical storms or hurricanes every year, it is not unusual to have considerable rainfall and moderate winds associated with tropical weather systems that pass some distance away. Annual rainfall in Monroe County is the lowest in Florida (Monroe County, 2001a). The prevailing winds are from the southeast during spring and summer and from the northeast in fall.

The overarching stormwater concern for residents of Monroe County is the low-lying topography combined with the threat of flooding by hurricane-driven storm surges. As described in Section 3.2.4, the majority of the Keys lies within the 100-year floodplain, and is classified as an area of special flood hazard (Monroe County, 1997). Because of the combination of the proximity to the ocean, dense vegetation, permeable soil, and unlimited outfall capacity of the surrounding water bodies, the citizens of Monroe County have traditionally given little concern to stormwater runoff (Monroe County, 1997).

The Upper and Middle Keys are underlain by Key Largo Limestone, a highly permeable remnant of prehistoric reefs. This formation is filled with fissures and cavities that allow tidal seawater to move freely in and out of the rock structure. Rainfall quickly permeates the rock and combines with the seawater. In the Lower Keys, the upper stratum of bedrock is Miami Oolite, a very porous, solution riddled, carbonate rock. The vertical permeability of the Miami Oolite is extremely high, but many of the solution pipes are not interconnected, leading to a much lower horizontal permeability. This low horizontal permeability limits the intermixing of rainfall and seawater and gives rise to the fresh water lenses found in some of the Lower Keys (Monroe County, 1997). Although few data exist, Monroe County has represented U.S. 1 as the topographic divide for each island, whereby lands to the bay side of U.S. 1 drain mainly toward Florida Bay and lands to the ocean-side of U.S. 1 drain toward the Florida Straits (Monroe County, 2001a).

Stormwater discharge is regulated on the Federal level through the CWA and the National Pollution Discharge Elimination System (NPDES) permit programs. The State of Florida has designated the SFWMD to regulate surface waters within the district that includes all of Monroe County. Under Part IV of Chapter 373, Florida Statutes, and rule Chapter 40E-4, and 40E-40 F.A.C., the SFWMD is responsible for permitting the construction, alteration, maintenance and operation of most real property improvements, which are designed to control surface waters. An applicant for a surface water permit must show that the proposed project would not be harmful to the water resources of the SFWMD. In addition, the operation and maintenance of the systems cannot be inconsistent with the overall objectives of the District or be harmful to the water resources of the District. Additionally, the SFWMD has been delegated stormwater quality responsibility by FDEP under Chapter 17-25 F.A.C. Within the Keys, SFWMD requires an Environmental Resource Permit (ERP) for the alteration of a natural drainage. Among other activities, the ERP process regulates developments greater than 10 acres or one acre or more of construction by requiring the implementation of BMPs (Monroe County, 2001a). In August 2001, Monroe County released a Stormwater Management Master Plan (SMMP), an integrated approach

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for addressing stormwater management throughout the Keys that includes proposed management alternatives (Monroe County, 2001a).

In the past, property owners and developers were responsible for drainage projects. Dredge spoil from canal construction was used to fill low areas and mosquito ditches were cut to drain natural wetlands. Boat canals were treated as primary drainage facilities with building sites draining directly into them by sheet flow, or ditches or percolation. On several Keys, ditches along U.S. 1 have served as the primary drainage system, transporting stormwater along the axis of the highway to the ocean. Much of U.S. 1 lacks an organized drainage system (Monroe County, 1997).

In all, 254 structures were located as of the SMMP inventory. Of the structures found, 167 or 66% had a water quality treatment system (infiltration trench or detention/retention pond). Inlets were found on 110 structures, 64 systems had wells, and four systems had oil/water separators (Monroe County, 2001a). The results of surveys conducted as part of the SMMP found that swale treatments were the predominant form of BMP currently in use (Monroe County, 2001a).

In the Keys, stormwater runoff from roadways, bridges, driveways and yards, rooftops, and shopping center parking lots contribute stormwater loading to nearshore waters. Section 3.10 describes land use in the Keys that constitutes a major factor in the amount and quality of stormwater runoff. Each land use has characteristic imperviousness and associated pollutants. The largest percentage of land is vacant (34.4%), followed by conservation (33.7%). Single-family residential land uses account for 13.7% and all other land uses represent about 5% or less of the total (Monroe County, 2001a). Estimates of total loadings of nitrogen and phosphorus from wastewater and stormwater from the Keys' land surface were summarized in the Phase II Report of the WQPP (EPA, 1993a). Recent estimates attribute about 20% of the TN load and about 45% of the TP load to stormwater (EPA, 1993a; Kruczynski, 1999).

In July 1999, a study was conducted to identify water quality "hot spots" that are likely stormwater induced problem areas. These stormwater induced "hot spots" were selected from the initial list of water quality hotspots that were identified as part of the WQPP and were mainly attributed to wastewater contamination. The criteria for ranking problem areas was based on flood severity, expected growth, expected county benefit, priority, and water quality benefit (Monroe County, 2001a).

According to the SMMP, 15 problem areas have been selected for retrofit improvements and 10 problem areas that are already permitted but need rehabilitation were selected for rehabilitation. The implementation of the recommendations and projects proposed in the SMMP began in fall 2001 and continue over the course of the next 4 or 5 years on rights-of-way and county properties (Garrett, Pers. Comm., 2001). The locations of the proposed stormwater improvement projects are shown in Figure 3-6.

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INSERT FIGURE 3-6: STORMWATER

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3.2.3.2 Environmental Consequences

3.2.3.2.1 Alternative 1 – No Action Alternative

The project applicant would not receive FEMA funding to help meet Florida Statutory Treatment Standards by the year 2010. As described in Section 3.2.2.2.1, the installation and upgrading of WWTPs and conversion of OWTS to clustered OWNRS are expected to lead to incremental improvements to canal and nearshore marine waters (i.e., 92 and 86% reductions in TN and TP loadings, respectively, Appendix D). Although treated to significantly higher BAT or AWT standards, depending on the quantity of wastewater treated, the input of nutrients to the shallow groundwater body would continue, but at reduced rates. In order to quantify the extent of water quality improvements more specifically, a comprehensive evaluation of the present water quality situation would be required. This would include an extensive series of test wells and monitoring throughout the Keys. In order to evaluate the timing of water quality improvements both onshore and offshore, it would be necessary to carry out simulation modeling of the groundwater systems and the effect of nutrient contamination on nearshore and offshore waters.

Implementation of the No Action Alternative is expected to result in generally positive effects on the water quality of stormwater flows. Under the No Action Alternative, the Monroe County community, including residents, businesses, and local government would be required to implement wastewater management projects to meet Florida Statutory Treatment Standards. The construction of WWTPs would replace OWTS systems, many of which overflow during storm events leading to nutrient pollution and fecal contamination of canals and nearshore waters. The conversion of OWTS to clustered OWNRS under this alternative is also expected to have a beneficial effect on the water quality of stormwater flows.

3.2.3.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

This alternative would involve the construction or upgrade of WWTP systems with the assistance of FEMA funding. The environmental consequences to inland, nearshore, and offshore water are closely related to those described under groundwater because of the connectedness between groundwaters and canal and nearshore waters (Sections 3.1.3 and 3.2.2).

As described in Section 3.2.2.2.1, improvements to water quality are expected under this alternative on the order of 92 and 86% reductions in TN and TP loadings, respectively, under the model assumptions outlined in Appendix D. However, it is difficult to determine the exact extent of these improvements due to a number of unknown variables. These include the length of time it would take to flush out present levels of nutrients and other pollutants currently found in groundwater, variations between Keys in terms of localized hydrogeologic characteristics, and the extent to which limestone aquifer can actually remove phosphorus from injected effluent.

Based on the results of the studies referenced in Section 3.2.3.1.2, it may be expected that WWTP projects in the Upper Keys would result in greater localized improvements to canal and nearshore marine waters than projects located in the Middle Keys because offshore and nearshore waters in the Middle Keys receive greater quantities of nutrients from Florida Bay waters, an additional source of nutrient inputs (Kruczynski, 1999; Szmant and Forrester, 1996).

The project applicant would be required to develop and implement a stormwater management plan as part of its WWTP engineering and operation designs in order to adequately accommodate stormwater flows on site. Construction activities of the WWTP would require a NPDES permit

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from the SFWMD if the facility results in ground disturbance in excess of 5 acres, as well as a general stormwater permit for the operation of the facility, itself. The implementation of a stormwater management plan would include specific measures such as storm inlets, swales, and/or drain wells to control stormwater runoff and prevent effects on stormwater quality.

The use of erosion control BMPs would be employed during construction activities to reduce soil erosion from entering stormwater flows, canals, and nearshore marine waters. Construction of the treatment plant facility would require several permits from FDEP in accordance with F.A.C. Applicable permits for the wastewater facility are referenced in Appendix E, Applicable Permit Information.

Collection Options: Vacuum Pumping (Option 1) and Low-Pressure Grinder Pump Sewer System (Option 2)

Insofar as environmental effects on inland and nearshore water quality are concerned, there is little basis for choice between options. Assuming proper design and reasonable operating conditions, neither would result in adverse impacts on stormwater flows or quality assuming proper maintenance.

Disposal Option 1 – Shallow Injection Wells

As explained in Section 3.2.2, Groundwater, the injection of effluent through shallow wells migrates to inland and nearshore waters rapidly. Although the effluent would be treated to BAT or AWT standards, the effluent would have a higher level of nutrients than ambient nearshore waters. In order to quantify the extent of water quality improvements more specifically, a comprehensive evaluation of the present water quality situation would be required. This would include an extensive series of test wells and monitoring throughout the Keys. In order to evaluate the timing of water quality improvements both onshore and offshore, it would be necessary to carry out simulation modeling of the groundwater systems and the effect of nutrient contamination on nearshore and offshore waters.

Disposal Option 2 – Wastewater Reuse

Under this alternative, treated effluent would be available for irrigation, dust control, car washes, lawns, laundry, ponds, and other accepted uses. FDEP regulates the reuse of treated wastewater through its Domestic Wastewater and Water Reuse Programs in accordance with Florida State objectives in Section 373.250 and Section 403.064 Florida Statutes of encouraging and promoting reuse. For the reuse of reclaimed water, wastewater must be treated to secondary treatment, with basic disinfection and pH control for non-edible agricultural and land application. Additional levels of preapplication treatment, such as high level disinfection, is required by FDEP as a result of: the method of reclaimed water or effluent application/ distribution, the extent of intended public access, the characteristics of the potential receiving nearshore water or ground protection pursuant to reuse or effluent disposal provisions of Chapter 62-610, F.A.C. Definitions of high level and basic disinfection are in Section 3.6.4.2.1. These uses would not likely adversely affect inland, nearshore or offshore waters provided that required permitting is obtained and effluent standards are met. The application of treated effluent for irrigation purposes, such as maintaining lawns and landscaping, is not expected to have a significant negative impact on marine or terrestrial resources. The relatively low level of TP in treated

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effluent would be largely removed by precipitation or **adsorption** on contact with limestone bedrock (Corbett et al., 1999). TN in treated effluent would be largely taken up by terrestrial plant biomass (e.g., lawn grasses and other landscape plants). Although some fraction of these nutrients could be re-released as the biomass decays, the fraction of TN returned to the system is expected to be negligible. Further details regarding the application method and required effluent treatment standards would be included in the project-specific SER.

3.2.3.2.3 Alternative 3 – On-Site Treatment Upgrades

As the shallow groundwaters of the Keys discharge nutrients to nearshore marine waters, the environmental consequences of the alternative mirror those described under Section 3.2.2, Groundwater. The principal differences are that part of the TP loading to groundwater probably is removed by adsorption on limestone of the aquifer (Kruczynski, 1999), and direct discharges to marine waters by outfalls and boats do not apply to groundwater. These latter nutrient contributions as of 1996 (Ayres Associates, 1998) comprised 320 lbs/day and 84 lbs/day of TN and 36 lbs/day and 30 lbs/day of TP, respectively.

Ayres Associates (1998) concluded that AWT could be met for BOD, TSS, and TP by OWNRS using engineered media SDI systems or by combining other systems/processes tested in the field. They concluded further that by using biological treatment, which incorporates nitrification/denitrification and discharges to an engineered SDI system, TN could be reduced by 85%. Thus, under the assumption that all OWTS are replaced by suitably designed OWNRS and package plants are upgraded to comparable limits, the TN loading to groundwater from wastewater disposal, and hence to surface waters, could be reduced to about 300 lbs/day, or less than the 475 lbs/day allocated to stormwater runoff. With TP at the AWT limit of 1 mg/L, the groundwater contribution of TP loading to nearshore marine waters would be reduced by an estimated 86% as discussed in Appendix D.

The conversion of OWTS to clustered OWNRS systems is expected to have a positive effect on stormwater quality. OWNRS systems would replace cesspits and septic tanks that have been identified as significant contributors to poor water quality in canals and nearshore waters. Currently, most OWTS systems do not have the capability to withstand increased storm flows and the release of untreated effluent presents a severe canal and nearshore water quality problem. As part of the establishment of clustered OWNRS, the project applicant would be required to develop a stormwater management plan to ensure OWNRS facilities adequately accommodate and protect against increased storm flows. A NPDES permit from SFWMD may be required depending on the degree of disturbance during construction. The SER would evaluate the quantity of ground disturbance when site-specific construction designs are available.

3.2.4 Floodplains and Wetlands

3.2.4.1 Affected Environment

3.2.4.1.1 Floodplains

EO 11988, Floodplain Management, requires Federal agencies to take action to minimize occupancy and modification of floodplains. Furthermore, EO 11988 requires that Federal agencies proposing to site a project in the 100-year floodplain consider alternatives to avoid adverse effects and incompatible development in the floodplain. According to 44 CFR Part 9,

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critical actions, such as developing hazardous waste facilities, hospitals, or utility plants, must occur outside of the 500-year floodplain. If no practicable alternatives exist to siting a project in the floodplain, the project must be designed to minimize potential harm to or within the floodplain. Furthermore, a notice must be publicly circulated explaining the project and the reasons for the project being sited in the floodplain. FEMA applies the Eight-Step Decision-Making Process outlined in 44 CFR Part 9 to ensure that it funds projects consistent with EO 11988. By its nature, the NEPA compliance process involves the same basic decision-making process as the Eight-Step Decision-Making Process. In effect, the Eight-Step Decision-Making Process has been applied through implementing the NEPA process. As part of the individual SERs, the Eight-Step process would be followed.

The present floodplain maps for Monroe County were completed in December 1998. A review of the FEMA's computerized Q3 floodplain maps indicated that almost all of Monroe County is within the 100-year flood zone (Figure 3-7). Most of the land area in the Keys is two to three feet above mean high tide. Maximum elevations reach 18 feet in two locations. As a result, the Keys are extremely susceptible to storm surge flooding (Monroe County, 1997).

Floodwater sources potentially affecting the Keys include the Florida Straights, Florida Bay, Biscayne Bay, and the Gulf of Mexico. In general, coastal areas that border these water bodies are subject to storm surge flooding as a result of hurricane and tropical storm activity. Large tidal surges combined with wave action and heavy rainfall that accompanies these storms can result in severe flooding (Monroe County, 1997).

In 1989, FEMA completed a detailed coastal flooding analysis of the complete coastline of Monroe County. This study investigated the existence and severity of flood hazards, and both floodplain maps and flood elevations were developed. Analyses were carried out to establish the peak elevation-frequency relations for each flooding source. Hydraulic analyses, considering storm characteristics and the shoreline and bathymetric characteristics of the water bodies studied, were completed to provide estimates of the elevations of floods of the selected recurrence intervals along all shorelines in the Keys (FEMA, 1999). Flood zone designations, which have been assigned to areas within Monroe County, are as follows (FEMA, 1999).

Zone AE: corresponds to the 100-year floodplain that is determined in the Flood Insurance Study by detailed methods. Whole-foot base flood elevations derived from the detailed hydraulic analysis are shown at selected intervals within this zone.

Zone VE: corresponds to the 100-year coastal floodplain that has additional hazards associated with storm surge. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X: corresponds to areas outside the 100-year floodplain, areas of 100-year floodplain where average flood depths are less than one foot, areas of 100-year floodplain where the contributing drainage area is less than one square mile, and areas protected from the 100-year flood by levees. No base flood elevations of depths are shown within this zone.

Flood elevations for the coastal storm having a recurrence interval of 100 years (Zone AE) range from 7 feet to 12 feet National Geodetic Vertical Datum (NGVD). Below this elevation, the 100-year storm event would flood most areas (Monroe County, 1997).

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INSERT FIGURE 3-7: FLOODPLAIN

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Only a few Keys have land that lies above the 100-year flood elevation (within Zone X). This includes land along US Hwy 1 on Key Largo, Plantation Key, Windley Key, and Upper Matecumbe Key, comprised of a strip encompassing the highway right-of-way and adjacent lands about 1,000 feet in width. The only exception is on Key Largo from the Card Sound turnoff south to Florida 107, where the area outside of the floodplain narrows to include only the US Hwy 1 right-of-way. Other areas in the Keys outside of the 100-year floodplain include the sites of the US Hwy 1 bridge abutments on Big Pine Key at Spanish Harbor Channel and North Pine Channel (Monroe County, 1997).

3.2.4.1.2 Wetlands

The term “wetland,” refers to areas that are inundated or saturated by surface or groundwater at a frequency and duration within 18 inches of the surface, sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, lakes, rivers, streams (including intermittent streams), mudflats, sloughs, and similar areas.

Under EO 11990 (Protection of Wetlands), Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and preserve and enhance their natural and beneficial values. If a Federal action has the potential to impact jurisdictional waters of the United States as defined by Section 404 of the CWA, the USACE would be contacted for appropriate permitting requirements. Section 404 of the CWA authorizes the USACE to issue permits, after notice and opportunity for public hearing, for the discharge of dredged or fill material into U.S. waters at specified disposal sites. FEMA applies the Eight-Step Decision-Making Process, required by 44 CFR Part 9, to meet the requirements of EO 11990. A step-by-step analysis of the Eight-Step Decision-Making Process as applied to the specific projects would be documented in the SER.

Most wetlands in the project area are coastal tidal wetlands, consisting of mangrove swamps, salt marshes, and salt pans. Marine seagrass meadows may also fall under the wetlands definition. Descriptions of wetlands communities, if applicable, would be included in the SER once specific sites are selected. In many cases, Keys wetlands are unusual in that they may develop directly on the limestone bedrock with very little soil and thus little evidence of characteristic wetland soils. Freshwater wetlands are very rare in the project area due to the low elevations, shallow soils, and limited freshwater availability. Their occurrence is largely limited to areas where rainfall may accumulate in depressions, forming shallow rockland lakes and wet prairie wetlands.

3.2.4.2 Environmental Consequences

3.2.4.2.1 Alternative 1 – No Action Alternative

Monroe County wastewater system owners/operators would likely undertake a number of WWTP and clustered OWNRS projects to meet Florida Statutory Treatment Standards by 2010. Given the fact that most of the Keys lie within the regulated 100-year floodplain, siting of individual projects outside of the floodplain would be difficult. While floodplain locations should be selected as project sites only if no reasonable alternative exists, it is expected that most selected sites would affect floodplains either partially or wholly given the predominance of floodplain designated areas in the Keys. Monroe County Ordinance Sections 9.5-315, 9.5-316, and 9.5-317 specify that public facilities such as water and gas main, electric, telephone and

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sewer lines, and streets and bridges be protected from high flood hazards. For non-residential structures, instead of elevating the structure to the base flood elevation (BFE), the structure may be designed such that structure below the BFE is watertight, with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

In accordance with 44 CFR 60.3 (e) (4), building structures in a VE Zone floodplain must be floodproofed or elevated with solid walls to prevent operational failure and structure damage during storms and flooding. Fill is not feasible for structural support for buildings within a VE Zone because of the severe erosion potential of such locations. Limited fill is allowed for landscaping, local drainage needs, and to smooth out a site for an unreinforced concrete pad. The stringent design standards for facilities located in the VE Zone would make the selection of these sites for wastewater facilities either infeasible from an engineering standpoint or cost prohibitive.

Impacts to wetlands and other jurisdictional waters of the United States regulated by USACE under the CWA have the potential to be negatively impacted by the No Action Alternative. Depending on the extent of wetland impacts from construction activities, a local, State, and/or USACE permit may be required. USACE's policy requires wetland effects be avoided or minimized before any permits are issued. The FDEP also regulates activities within wetlands through the ERP process (Chapters 62-341, 343, and 330, F.A.C.). The State permit process includes other stormwater systems and related activities that may affect wetlands or surface waters. The Monroe County Land Development regulations require County review of wetlands as potential habitat areas. The net effect of the various wetland permit requirements is to avoid or minimize adverse impacts.

3.2.4.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

As with the No Action Alternative, it is expected that most selected sites would affect floodplains given the predominance of floodplain designated areas in the Keys. If structures associated with the wastewater treatment alternatives (e.g., WWTPs, pump stations, etc.) are constructed in the floodplain, they must be floodproofed or elevated with fill or solid walls to prevent operational failure and structure damage during storms and flooding. Standards and regulations pertaining to construction in the floodplain in Monroe County are promulgated in amendments to Monroe County Ordinance. These amendments specify design features required for structures proposed in the floodplain and vary depending on the level of flood hazard. As specified in 44 CFR 9, structures must be elevated such that the lowest floor of the structures is at or above the level of the base flood. For non-residential structures, instead of elevating to BFE, the structure may be designed such that structure below the BFE is water tight, with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

Additionally, there is a public concern that the proposed WWTP would lead to further development of the floodplain within the project area by introducing key infrastructure, which is often linked to additional development. However, development within the Keys is not controlled by addition of key infrastructure, but instead by Monroe County's ROGO permit allocation system as described in Section 3.10. The construction of new wastewater treatment infrastructure in the Keys is essential to effectively treat existing wastewater flows, and is not proposed as a way to introduce or support increased development. Therefore, if growth and development in the floodplain occurs following implementation of this alternative, it is a function of established

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county planning and is not directly related to proposed projects for wastewater management improvements. Given the above points, an evaluation of secondary effects on floodplains with regard to the potential for increased development under the alternatives was not conducted.

While adverse effects are expected to be minimal, this alternative has the potential to affect wetlands. Effects would be evaluated within the site-specific SERs. Much as described in Section 3.2.4.2.1, depending on the extent of wetland impacts from construction activities, a local, State, or USACE permit may be required. USACE maintains a policy that wetland impacts should be avoided or minimized before any permits are issued. The FDEP also regulates activities within wetlands through the ERP process (Chapters 62-341, 343, and 330, F.A.C.). The State permit process includes other stormwater systems and related activities that may affect wetlands or surface waters. The Monroe County Land Development regulations require County review of wetlands as potential habitat areas. Moreover, should a wetland be affected under this alternative, the previously described Eight-Step-Decision-Making Process would be triggered. The net effect of the various wetland permit and Executive Order requirements is to avoid or minimize adverse impacts.

Collection Option 1 – Vacuum Pumping

Aside from the construction activities described above in Section 3.2.4.2.2, the selection of the vacuum pumping collection option is not expected to result in any major effects on wetlands and floodplains.

Collection Option 2 – Low-Pressure Grinder Pump Sewer System

Aside from the construction activities described above in Section 3.2.4.2.2, the selection of the low-pressure grinder pump sewer system is not expected to result in any specific effects on wetlands and floodplains.

Disposal Option 1 – Shallow Injection Wells

Siting of wastewater injection wells may affect jurisdictional wetlands if the project activities would result in the fill or alteration of wetlands. Project-specific effects on wetlands and floodplains would be considered in the SER for the individual project.

Disposal Option 2 – Wastewater Reuse

Selection of wastewater reuse as a disposal option is not expected to result in the fill or modification of wetland areas or floodplains.

3.2.4.2.3 Alternative 3 – On-Site Treatment Upgrades

The conversion of OWTS to clustered OWNRS may require the importation, movement, and/or excavation of a limited amount fill used in grading activities. Effects on floodplains are similar to those described under the Section 3.2.4.2.2, Centralized Wastewater Treatment Plant Alternative. Effects on wetland areas as a result of this alternative would be evaluated in the site- and project-specific SER.

3.3 BIOLOGICAL RESOURCES

Natural vegetation and habitat in the Keys includes six major terrestrial communities (pine rocklands, tropical hardwood hammocks, mangroves, salt marsh, freshwater systems and dunes/coastal ridges) and four major marine communities (seagrasses, coral reefs, hardbottom and sandy bottom). It is important to note that much of the land area in the Keys has been significantly altered (fragmented) by human activities, including clearing for residential and commercial uses. Natural vegetation in these areas has largely been replaced by planted ornamental species and weedy and exotic species. Brazilian pepper (*Schinus terebinthifolius*) and Australian pine (*Casuarina equisetifolia*) are two of the more ubiquitous exotic nuisance species that tend to invade disturbed upland and wetland habitats. Terrestrial and aquatic environments are discussed separately in the following two sections.

3.3.1 Affected Environment

3.3.1.1 Terrestrial Environment

3.3.1.1.1 Pine Rocklands and Tropical Hardwood Hammocks

The terrestrial habitats in the Keys are underlain by a limestone substrate, with varying amounts of overlying sand or organic matter. Throughout most of the Keys, the limestone is a fairly hard coral reef limestone, but in the Key West and Sugarloaf Key area of the Lower Keys, the substrate is a friable oolitic precipitate limerock. The relative abundance of pine rockland and tropical hardwood hammocks on these substrates is largely a function of elevation and a lack of natural fire occurrence.

Pine rocklands are limited in the Upper Keys, but abundant in the Lower Keys, with somewhat extensive pinelands occurring on Big Pine, Little Pine, No Name, Cudjoe, and Sugarloaf Keys. Pine rocklands are upland forest communities with an open canopy dominated by the native Florida slash pine (*Pinus elliottii* var. *densa*). Keys pine rocklands are fire-adapted and dependent on periodic fires for their long-term persistence. Surrounded by wet prairie habitats and/or mangroves, pinelands typically occur on locally elevated areas of bedrock, which may flood seasonally or during extreme storm events. Xeric conditions in this habitat are partly caused by locally low rainfall and the exposed rock ground cover. Vegetation is dominated by canopy of Florida slash pine. The extent of subcanopy development in a pineland is dependent upon the frequency of surface fires. Pine rocklands with a well-developed subcanopy typically include species such as saw palmetto (*Serenoa repens*), strongbark (*Bouyeria cassinifolia*), locust berry (*Byrsonima lucida*), silver thatch palm (*Coccothrinax argentata*), pineland croton (*Croton linearis*), rough velvetseed (*Guettarda scabra*), wild sage (*Lantana involucrata*), and long-stalked stopper (*Psidium longipes*). Shrub vegetation includes caesalpinia (*Caesalpinia pauciflora*), dune lily-thorn (*Catesbaea parviflora*), pisonia (*Pisonia rotundata*), and pride-of-Big-Pine (*Strumpfia maritima*) (Snyder et al., 1990).

Tropical hardwood hammocks occur on slightly higher elevations not exposed to saltwater flooding and have a better-developed soil layer of largely organic matter. Along with pinelands, tropical hardwood hammocks represent the climax upland community type in the Keys and are second in terms of biodiversity (Ross et al., 1992). Tropical hardwood hammocks in the Keys are

closed, broad-leaved forests that occupy elevated, well-drained, and relatively fire-free areas. Tropical hardwood hammocks are comprised of more than 150 species of tropical trees and shrubs (Snyder et al., 1990). Common dominant species throughout the Keys include gumbo limbo (*Bursera simaruba*), pigeon plum (*Coccoloba diversifolia*), and white stopper (*Eugenia axillaris*). Other species have a more regional occurrence, such as mahogany (*Sweitenia mahagoni*) and mastic (*Sideroxylon foetidissimum*), which are not present in the Lower Keys and wild tamarind (*Lysilomalatisiliquum*) (which is much less common in the Lower Keys). Other canopy species may include Jamaica dogwood (*Piscidia piscipula*), live oak (*Quercus virginiana*), cabbage palm (*Sabal palmetto*), willow bustic (*Bumelia salcifolia*), and strangler fig (*Ficus aurea*). Common understory species are inkwood (*Exothea paniculata*), white stopper, poisonwood (*Metopium toxiferum*), marlberry (*Ardisia escallonioides*), lancewood (*Nectandra coriacea*), satinleaf (*Chrysophyllum oliviforme*), Spanish stopper (*Eugenia foetida*), torchwood (*Amyris elemifera*), cinnamon-bark (*Canella winterana*), strongbark (*Bourreria ovata*), soapberry (*Sapindus saponaria*), myrsine (*Myrsine floridana*), wild coffee (*Psychotria nervosa*), and black ironwood (*Krugiodendron ferreum*). Undisturbed hammocks generally have a very sparse herbaceous cover, usually including panic grass (*Panicum dichotomum*), woods grass (*Oplismenus steterius*), and blue paspalum (*Paspalum caespitosum*), Boston fern (*Nephrolepis exaltata*), sword, and several orchids such as wild coco (*Eulophia alta*) and ladies tresses (*Spiranthes* spp.) (USFWS, 1999; Meyers and Ewel, 1990).

3.3.1.1.2 Mangrove Forests and Salt Marshes

Mangrove forests and salt marshes form an important transition between the upland and marine systems. These communities are an important buffer zone, filtering nutrients, solids, and pollutants from stormwater runoff, stabilizing sediments, protecting the shoreline from erosion, and providing food, nesting and nursery areas for many fish and wildlife species.

Throughout the Keys, mangrove forests form the predominant coastal vegetation community. Mangroves are found along the edges of shorelines, bays and lagoons and on over wash areas throughout the Keys. In 1974, the Coastal Coordinating Council estimated that there were 94,810 hectares (ha) of mangrove forests in Monroe County. Due to more stringent dredge and fill laws enacted between 1975 and 1989, it is unlikely that this number has changed significantly.

Mangrove communities consist of facultative halophytes, tolerant of anaerobic saline soils and periodic tidal flooding. Red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), and white mangrove (*Laguncularia racemosa*) are the dominant species in mangrove forests in the Keys. Mangrove forests in the Keys are generally of the “fringing forest” or “basin forest” types (Lugo and Snedaker, 1974). The fringing forests comprise fairly narrow bands along the shorelines, while basin forests occur in wider depression areas with less tidal flow and flushing. Red mangroves occur in the middle and lower intertidal zone and upper subtidal zone. Black mangroves dominate the upper intertidal zone and generally occur in a zone between red and white mangroves. White mangroves occur on the landward edge of mangrove forests, throughout the intertidal and in the upper portions of the forests. Ground cover within a mangrove forest consists of leaf litter and decomposing forest debris. Buttonbush (*Conocarpus erectus*) and blolly (*Guapira discolor*) may occur in the transition zone from mangrove forest to upland communities. Mangroves typically create a system with peaty soils with a low pH. The community’s biological productivity usually depends on external sources of carbon and nutrients, such as run off from terrestrial sources, tidal input, and bird droppings. Nitrogen

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fixation does occur, so that productivity is usually limited by other nutrients. Carbon export to marine systems is a major function of the mangrove community.

Mangrove ecosystems are important habitat for at least 1,300 species of animals including 628 species of mammals, birds, reptiles, fish, and amphibians as they provide areas for breeding, nesting, foraging, and shelter. Many of the larger motile species are not restricted to mangroves, but are seasonal or opportunistic visitors. However, most invertebrate and some resident vertebrate species are totally dependent upon mangroves to survive and complete important life cycle functions (Tomlinson, 1986). Fish and marine invertebrates are frequent visitors to mangrove communities, as are birds and mammals from nearby terrestrial systems (USFWS, 1999).

Salt marshes are not well developed in most of the Keys. These usually consist of largely monospecific (single species) stands of black needlerush (*Juncus roemerianus*) and salt marsh cordgrass (*Spartina alterniflora*). Other common species in the Keys include marsh elder (*Iva frutescens*), saltbush (*Baccharis halimifolia*), seaside goldenrod (*Solidago sempervirens*), salt grass (*Distichlis spicata*), sea purslane (*Sesuvium portulacastrum*), and mangroves. Sand or limerock areas at the upper end of the tidal range may have sea ox-eye (*Borrchia arborescens*), saltwort (*Batis maritima*), seablite (*Suaeda linearis*), and sea lavender (*Limonium carolinianum*).

3.3.1.1.3 Freshwater Systems

Although freshwater wetlands are widespread in southern Florida, less than 300 acres of freshwater marshes and 600 acres of forested freshwater wetlands remained in the Keys in 1991 (McNeese, 1998; Folk et al., 1991). Freshwater wetlands are restricted to areas landward of the seasonal high tide level and are primarily restricted to portions of the Lower Keys underlain by freshwater lenses (McNeese, 1998). Freshwater marshes in the Keys are typically isolated, seasonally flooded depressions dominated by sawgrass (*Cladium jamaicense*). Forested freshwater systems are generally pine forests with a sawgrass understory (McNeese, 1998). Freshwater wetlands and surface waters represent the only dry season source of freshwater for wildlife (McNeese, 1998). Freshwater systems also play an important role in attenuating nutrients and other contaminants in surface water runoff. The absence of fire from freshwater wetlands promotes the growth of woody exotic vegetation, including Brazilian pepper (*Schinus terebinthifolius*) and Australian pine (*Casuarina equisetifolia*) (Kushlan, 1990). Dominant species typically occurring within the Keys freshwater systems include buttonwood, sawgrass, fringe-rushes (*Fimbristylis* spp.), cattail (*Typha latifolia*), leatherfern (*Acrostichum danaeifolium*), and flat sedges (*Cyperus* spp.).

3.3.1.1.4 Dunes and Coastal Ridges

Dune systems form along sandy beaches where wind- and wave-borne sand is trapped and accumulated by extremely salt-tolerant low-lying beach vegetation. These growing sand piles are further colonized by plant species tolerant of salt spray, desiccating environments, shifting sands and high substrate temperatures (USDA, 1984); in the Keys, these “foredune” species include sea oats (*Uniola paniculata*), railroad vine (*Ipomoea pescaprae*) and beach bean (*Canavalia maritima*; USDA, 1984; Johnson and Barbour, 1990). Over time, the area landward of the foredune can support woody vegetation, including seagrape (*Coccoloba uvifera*) and bay cedar (*Suriana maritima*). Dune assemblages provide beach stabilization and help protect landward areas from wave action during storms. In the Keys, the persistence of dunes and coastal ridges is

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limited primarily by natural patterns of sand movement associated with wind and waves, construction of coastal structures, and human and vehicular traffic.

3.3.1.2 Aquatic Environment

3.3.1.2.1 Seagrass Beds and Sand Flats

Seagrass communities are the most abundant marine bottom community in the Keys, particularly in Florida Bay and the Gulf of Mexico (FMRI, 2000). Distribution of seagrass communities is influenced by the interaction of factors such as water quality, water depth, sediment depth, and current velocity (FMRI, 2000).

In the Keys, seagrass communities are dominated by turtle-grass (*Thalassia testudinum*) and manatee-grass (*Syringodium filiforme*), with shoal-grass (*Halodule wrightii*) becoming dominant in more eutrophic areas (Fonseca et al., 1998). These three species account for more than 95% of the total plant biomass in the FKNMS. Paddle-grass (*Halophila decipiens*) and star-grass (*Halophila englemannii*), although minor, are also widely distributed (FMRI, 2000). Also found scattered in the seagrass meadow areas throughout the Keys are benthic and epiphytic algae such as *Halimeda* spp., *Penicillus* spp., *Rhypocephalus* spp., *Caulerpa* spp., and *Udotea* spp. These algae may increase organic matter production, and decay of their calcareous skeletons adds to the cycling of calcium and carbon in the shallow ecosystem.

Seagrasses in the Keys generally occur at water depths ranging from intertidal to about 10 meters, with about 90% of all seagrass beds occur between depths of 3 to 6 feet (Kurz et al., 1999). *Thalassia* and *Syringodium* typically occur in the middle of the seagrass depth range, while *Syringodium* and *Halodule* can occur to depths of more than 20 feet (Williams, 1988).

Seagrass beds dominate the benthic habitat in the Upper Keys and are most predominant in Hawk Channel and Card Sound (FMRI, 2000). Sparser in the Middle Keys, seagrass beds are found shoreward of the reef tract on the Atlantic side and are extensive north of Marathon and Duck Key (FMRI, 2000). In the Lower Keys, seagrass abundance is variable with dense beds of *Thalassia* growing mostly in the Lakes Passage area on the Gulf side (FMRI, 2000).

Seagrass communities are among the most productive habitats of the nearshore environment (Livingston, 1990) and they provide critical nursery habitat and food for many fish and invertebrates. Seagrass beds also help trap suspended sediments and prevent the loss of accumulated sediment to wave and current action (Fonseca et al., 1998). Seagrass meadows also support endangered species such as the green sea turtle (*Chelonia mydas*) and West Indian manatee (*Trichechus manatus*).

3.3.1.2.2 Coral Reefs

EO 13089 (Coral Reef Protection) directs Federal agencies whose actions affect U.S. coral reef ecosystems and provides for the implementation of measures to reduce impacts from pollution, sedimentation, and fishing.

The Florida Coral Reef Tract represents the most extensive nearshore coral reefs of continental North America, and the reef is still actively building only in the Keys. The Florida Reef Tract extends from south of Miami to the Dry Tortugas (about 230 miles) on the Atlantic side of the Keys and does not occur on the West Florida shelf (FMRI, 1998; DeFreese, 1991). The largest reefs are east of large unbroken or tightly clustered islands such as Key Largo and the Lower

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Keys complex, where the islands act as barriers to the transport of silts and other materials from Florida Bay.

In the Florida Keys Reef Tract, there are two main categories of reefs: patch reefs and platform margin (bank) reefs. Patch reefs, which often are in shallower waters closer to shore, generally consist of small- to medium-sized clusters of corals surrounded by areas of barren sand or seagrasses. Platform margin (bank) reefs are those that form a more or less continuous structure parallel to the coastline. There are five classifications of platform margin reefs:

- Shallow spur and groove, which are well developed, actively accreting, platform margin reefs found on the fore reef of the reef tract.
- Drowned spur and groove, which are older platform margin reefs that are not actively growing and are often buried in sand that has migrated.
- Remnant – low profile reefs lack the distinctive spur and groove characteristics. The vertical relief of these reefs varies from 1.5 to 6.5 feet.
- Back reef, which is the landward section of the spur and groove type platform margin reefs. This is typically a rubble zone, colonized by heartier corals.
- Reef rubble areas, where unstable pieces of the reef fractured from wave action exist in these areas with little or no visible colonization.

In the Upper Keys, the reef tract is located about 6 miles offshore, forming an almost continuous community that parallels the Keys from Carysfort Reef at the north end to Crocker Reef at the south (FMRI, 2000). This area has a large abundance of patch reefs and well-developed bank reefs. The Middle Keys, which are smaller and separated by numerous wide channels connecting with Florida Bay, have limited reef development, largely due to a lack of protection from the variations in temperature, salinity and clarity of water coming from the Gulf of Mexico and Florida Bay (FMRI, 2000). In the Lower Keys, the reef tract extends from Looe Key Reef to Cosgrove Shoal, south of the Marquesas (FMRI, 1998).

Biodiversity of visible organisms is much higher on nearshore reefs than on sandy bottom. Epifaunal organisms flourish on the stationary foothold provided by the rock and are virtually absent in areas where shifting sands preclude settlement. Algae also flourish on this reef substrate. At the bottom of the food chain, algae provide a primary food source for a variety of organisms including invertebrates, fishes, and the federally listed green sea turtle. Fish are also more abundant on nearshore reefs. About 192 species are known to inhabit the nearshore reefs of South Florida (Lindeman, 1997).

Relatively abundant food fish species occur on nearshore and midshelf reefs. These include the sheepshead (*Archosargus probatocephalus*), the porkfish (*Anisotremus virginicus*), black margate (*Anisotremus surinamensis*), mutton snapper (*Lutjanus analis*), gray snapper (*Lutjanus analis*), black sea bass (*Centropristis striata*), flounder (*Paralichthys dentatus*), and gray triggerfish (*Balistes capriscus*). Juveniles of commercial importance include the gag grouper (*Mycteroperca microlepis*), red grouper (*Epinephelus morio*), and black grouper (*Mycteroperca bonaci*). Another abundant predator on the reefs is the sport and food fish, the common snook. Many other species are collected for aquariums. These include angelfish (*Pomacanthidae*), butterflyfish (*Chaetodontidae*), wrasses (*Labridae*), damselfish (*Pomacentridae*), and doctorfish (*Acanthuridae*). The smaller tropical fish are important ecologically as prey for grouper, snook,

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and other piscivores (fish eaters). Other important prey would include the silver porgy (*Diplodus argenteus*) and at least two species of mojarra (*Eucimostomus* sp.).

Recent assessments of the conditions of the Florida Reef Tract have indicated accelerating degradation. Bleaching, sedimentation, salinity, light availability, heavy rainfall, drought, temperature (winter cold fronts), algal overgrowth, coral diseases, and pollution from point and nonpoint sources contribute to the declining health of reefs (Dustan, 1999; Jaap, 1984). Recent research by Patterson et. al (2002), have linked white pox, a coral disease which causes irregularly shaped white lesions on elkhorn coral, to an enterobacterium, *Serratia marcescens*. Enterobacterium commonly inhabits the gastrointestinal tract of humans and other animals, and can also be free-living in soil and water. In addition to *S. marcescens*, other bacteria associated with human fecal matter, have been found to be concentrated on the mucoid surface layers of corals in the Florida Keys (Lipp et al, 2002, as cited in Paterson et. al, 2002).

3.3.1.2.3 Hardbottom

Low-relief hard-bottom communities are characterized by their proximity to shore, shallow depth (<3 m), and visual dominance of octocorals (Chiappone and Sullivan, 1994). These communities occur within 1.25 miles of shore on either side of the Keys at depths of about 3 to 16 feet (Chiappone and Sullivan, 1996). Hard-bottom communities in the Keys and adjacent Florida Bay exhibit extreme variability in terms of community size, dominant species, and community structure response to environmental parameters (Jaap, 1984). These communities provide refuge for juvenile stages of species of interest for fisheries (e.g., *Panilirus argus*), may serve as preliminary indicators of eutrophication, and affect the nearshore-to-offshore recruitment of invertebrate and fish larvae (Chiappone and Sullivan, 1994).

3.3.1.2.4 Sandy Bottom

Bare bottom communities, over either calcareous muds or calcareous sand, are devoid of macrophytes, specifically algae and seagrasses. The typical flora of these areas includes calcareous algae, such as *Udotea*, *Halimeda*, and *Penicillus*. The fauna is sparse, typically dominated by sponges and small corals (Chiappone, 1996).

3.3.2 Environmental Consequences

3.3.2.1 Alternative 1 – No Action Alternative

Improved wastewater management activities would be implemented to meet the new Florida Statutory Treatment Standards. However, without FEMA funding, the rate at which wastewater treatment improvements are made would be slower than under Alternatives 2 and 3, while project applicants identify additional financing options. Adverse effects on nearshore marine environments, such as coral reefs, would continue as a result of inadequate septic tanks and cesspools/cesspits potentially releasing high levels of nutrients into shallow groundwater.

Once funding is identified and necessary permits obtained, construction would begin. Construction of new facilities or additions to existing facilities could result in vegetation or habitat loss of about 1 to 5 acres for each facility depending on specific site design. Since most facilities are expected to be located near highly developed areas, many potential sites may be degraded and have reduced habitat value. If no other suitable sites are available, some loss to

high quality habitat areas could result from construction. The potential for effects to high quality upland habitat (e.g., tropical hardwood hammocks) is higher for the Upper Keys project area.

Beneficial effects on nearshore marine habitats including seagrass meadows and coral reefs would likely occur due to the reduction of TSS, nutrients, and pathogens released to the nearshore waters by runoff and seepage in the surficial aquifer from cesspools, septic tanks, and small package treatment systems that would be replaced by the WWTPs. Corals typically thrive in an oligotrophic (nutrient-poor) environment with the assistance of specialized symbiotic algae (i.e., zooxanthellae); these algae derive their nutrients from the waste products of their coral hosts and, as such, are not typically limited by the availability of free nutrients from the water column (Hallock et al., 1993). Nutrients released into the marine water column by existing treatment systems may negatively impact marine communities in several ways. First, these nutrients may contribute to the rapid growth of phytoplankton, resulting in algal “blooms” that reduce water clarity, decrease light penetration, and decrease seagrass and coral growth. Second, nutrients tend to favor the growth of non-symbiotic mat-forming macroalgae, which strip nutrients from the water column, enabling them to grow quickly and colonize hardbottom areas that could otherwise support slower-growing stony corals (Dustan, 1999). These non-symbiotic macroalgae can out-compete and shade corals, causing bleaching and eventual death.

Other benefits of decreased TSS and nutrient release may include increased growth of seagrasses due to increased light penetration. Algal blooms may also become less frequent, pervasive and damaging as a result of reduced TP and TN concentrations.

While nutrients (particularly TP) from existing cesspits and septic tanks could theoretically contribute to the growth and productivity of mangroves (Snedacker and Lugo, 1973), no documentation or other evidence suggests that mangrove communities in the Keys are nutrient limited (Odum and McIvor, 1990). Therefore, a reduction in nutrients caused by wastewater management upgrades is not likely to negatively impact mangroves.

It should be noted that the beneficial impacts of improved water quality to marine resources would be most prevalent in nearshore waters because much of the nutrients released into nearshore waters are taken up by marine flora (Hallock et al., 1993).

Concerns have been raised about the possible environmental effects of using liquid chlorine to disinfect wastewater. Since chlorine is toxic to aquatic life at low concentrations, wastewater in Florida that is released directly into surface water is dechlorinated (Klineman, Pers. Comm., 2002). Dechlorination, however, is not required for all discharges. It increases chlorination costs by 30 to 50% and the long-term effects of dechlorinated compounds on the environment are unknown (EPA, 1999). In addition, chlorine is so reactive that it is not likely to move through the ground and enter groundwater or to be stored by plants and animals (EPA, 1994c).

The Monroe County Land Development Regulations have provisions to reduce the environmental impacts of development by encouraging design of a development on a parcel of land to incorporate clustering of the development away from the natural areas on the parcel that are the most susceptible to harmful development impacts (Monroe County Code (M.C.C.) Sec. 9.5-345). The regulations also require the preparation of a habitat analysis, and replacement or transplantation of certain native plant species, including tropical hammock vegetation and plant species used by wildlife (M.C.C. Sec. 9.5-335). Compliance with M.C.C. would minimize adverse effects to regulated plant communities.

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3.3.2.2 *Alternative 2 – Centralized Wastewater Treatment Plant Alternative*

Effects on and mitigation requirements for biological resources under Alternative 2 would be similar to those described under the No Action Alternative, Section 3.3.2.1. It is expected that beneficial impacts would occur more quickly under Alternative 2 because FEMA funding would be applied to the projects. Furthermore, beneficial effects to coral reef communities, as described above, would be consistent with the intent EO 13089, Coral Reef Protection.

Collection Option 1 – Vacuum Pumping and Collection Option 2 – Low-Pressure Grinder Pump System

This system requires the placement of several vacuum stations. Depending on location, construction of these buildings has the potential to result in some vegetation and habitat loss. Siting vacuum-pumping stations in developed, previously disturbed areas would minimize effects on biological resources. Sewer lines would be placed in existing utility rights-of-way and are not expected to adversely impact existing natural resources. Site-specific impacts would be further considered in the project-specific SER level.

Disposal Option 1 – Shallow Injection Wells

The effects on the biological environment of siting wastewater injection wells would be evaluated in the project-specific SER. The use of shallow injection wells for treated wastewater disposal is expected to result in improvement to water quality in areas that were previously serviced by cesspools and septic tanks on the order of 92 and 86% reductions in TN and TP loadings to nearshore marine waters (Appendix D). Although treated to Florida Statutory Treatment Standards, effluent would have a higher level of nutrients than ambient concentrations. There is little available research that specifically assesses the impact of effluent treated to BAT and AWT standards on biological resources in the Keys. As discussed in Section 3.3.2.1, in general, while mangrove swamps could benefit slightly from increases in TP, coral reefs prefer oligotrophic environments with clear waters and low turbidity and therefore would be adversely affected by increased nutrient levels. The major impetus for improving wastewater management in the Keys and installing WWTPs such as those proposed under this alternative is to improve the ecological health by reducing the pollutant load. Implementation of the WWTP that meets Florida Statutory Treatment Standards would reduce nutrient loading and result in a corresponding improvement to ecological health.

Disposal Option 2 – Wastewater Reuse

Treated wastewater would be available for application for irrigation, car washes, fountains, and other practical uses. Although treated to Florida Statutory Treatment Standards, recycled effluent would have higher level of nutrients than potable, freshwater that might otherwise be used. Generally, the effect on biological resources of wastewater reuse would be minimal for closed systems such as public fountains and car washes. The application of treated effluent for irrigation purposes, such as maintaining lawns and landscaping, is not expected to have a significant negative impact on marine or terrestrial resources. The relatively low level of TP in treated effluent would be largely removed by precipitation or adsorption on contact with limestone bedrock (Corbett et al., 1999). TN in treated effluent would be largely taken up by terrestrial plant biomass (e.g., lawn grasses and other landscape plants). Although some fraction of these

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nutrients could be re-released as the biomass decays, the fraction of TN returned to the system is expected to be negligible.

3.3.2.3 *Alternative 3 – On-Site Treatment Upgrades*

Effects and mitigation requirements to biological resources under Alternative 3 would be similar to those described under the No Action Alternative, Section 3.3.2.1. Beneficial effects are expected to occur more quickly under Alternative 3 because FEMA funding would expedite project implementation. Furthermore, beneficial effects to coral reef communities, as described above, would be consistent with the intent EO 13089 (Coral Reef Protection). Upgrading OWTS to clustered OWNRS would result in positive effects on water quality by greatly reducing the nutrient loading thereby lowering the potential for eutrophication, algal blooms and decreases in bio-available oxygen levels. Most upgrades to OWTS would be expected to occur in existing developed areas, such as residential areas, and business districts. As such, the effects on biological resources of siting clustered OWNRS are expected to be minimal. In order to assess the impact, site-specific SERs would evaluate impacts of the installation of clustered OWNRS on the immediate biological environment.

3.3.3 *Special Status Species*

3.3.3.1 *Affected Environment*

The Endangered Species Act (ESA) of 1973 requires Federal agencies to consider impacts of their actions on threatened and endangered species of fish, wildlife, and plants, and their habitats, and take steps to conserve and protect these species. National Marine Fisheries Service (NMFS) holds the responsibility for listing most marine species, and the USFWS administers the listing of all other plants and animals.

In addition to the requirements of ESA, Federal agencies must also comply with the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) that requires the identification of Essential Fish Habitat (EFH) for federally managed fishery species and the implementation of measures to conserve and enhance this habitat. In the Keys, federally regulated fisheries are managed through the Gulf of Mexico (GMFMC) and South Atlantic (SAFMC) Fishery Management Councils. A compiled list of the fishery species under GMFMC and SAFMC management are attached as Appendix F. Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (Magnuson-Stevens Act, 16 U.S.C. 1801 et seq.). The MSA requires Federal agencies to consult with NMFS on activities that may adversely affect EFH. There are many situations where designated EFH overlaps with the habitat (including critical habitat) of species listed as threatened or endangered under ESA. As described in guidance for integrating MSA and ESA published by NMFS, EFH consultation can be completed using the ESA Section 7 consultation process provided that the Federal action agency supplies the information required by 50 CFR 600.920(g) for an EFH Assessment, and NMFS clearly distinguishes its EFH Conservation Recommendations from ESA conservation recommendations under 50 CFR 402.14(j) or any other ESA measures or conditions. If NMFS has made a finding for another environmental review process that meets the requirements for completing EFH consultations, the

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Federal action agency may decide which process to use for any given EFH consultation (NMFS, 2001).

A list of federally protected species with the potential to occur in Monroe County was obtained from USFWS (USFWS, 2000). Additionally, a list of species under the jurisdiction of NMFS that have the potential to occur in Florida's Atlantic Coast and Gulf of Mexico was obtained from NMFS (NMFS, 2001). The compiled species list, including habitat type and likelihood of occurrence in the Keys, is included in Appendix F. A similar table documenting plants and animals listed for protection at the State level is provided in Appendix F.

Many of the native plant species are endemic to the region or are more characteristic of the Caribbean flora than of the temperate flora typical of the Florida mainland and the rest of North America. In contrast, most of the animal species are more characteristic of the temperate faunal element. In each case, numerous endemic subspecies and varieties have developed as a result of isolation in the islands of the Keys.

Threatened and endangered species in the Keys often have ranges that include several habitat types. However, certain communities provide the primary habitat for most species. Designated Critical Habitat, under the ESA, is present in the Keys for three species. Nearshore waters of Florida Bay and associated Sounds south to Long Key (approximate boundary of Everglades National Park) have been designated as Critical Habitat for the American crocodile (*Crocodylus acutus*). Similar waters south to Buttonwood Bay near Key Largo are designated Critical Habitat for the West Indian manatee (*Trichechus manatus*). All land areas above the mean low tide of Little Pine Key, Big Torch and Middle Torch Key, Water Keys, Raccoon Key, Johnston Key, and Saddlebunch, Cudjoe, and Summerland Keys north of US 1 are designated Critical Habitat for the Key rice rat (*Oryzomys argentatus*).

Federally listed species that occur in the pine rocklands and tropical hardwood hammocks in the Upper Keys include the Key Largo woodrat (*Neotoma floridana smalli*), Key Largo cotton mouse (*Peromyscus gossypinus allapaticola*), eastern indigo snake (*Drymarchon corais couperi*), Schaus' swallowtail butterfly (*Heraclides aristodemus ponceanus*). Key deer (*Odocoileus virginianus clavium*) use hammocks and pine rocklands in the Big Pine and No Name Key areas. Tropical hardwood hammocks are important forage habitats for the Stock island tree snail (*Orthalicus reses reses*). Pine rockland habitat also supports two plant species listed as Threatened or Endangered at the Federal level: the Key tree cactus (*Cereus robinii*) and Garber's spurge (*Chamaesyce garberi*) (Chafin et al., 2000).

Mangrove forests and other wetlands also are a key habitat for several federally listed species, including the American alligator (*Alligator mississippiensis*) Keys marsh rabbit (*Sylvilagus palustris hefneri*), American crocodile, eastern indigo snake, bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*) (Hipes et al., 2000). Additionally, the rice rat and key deer may be found in coastal wetlands on Big Pine Key and nearby islands in the Lower Keys. Unvegetated or poorly vegetated shorelines and beach/dune areas provide habitat for the roseate tern (*Sterna dougallii*). Waters adjacent to mangrove forests provide habitat for the West Indian manatee and numerous fish species.

Little use of disturbed habitats and developed areas is made by federally listed species in the Keys.

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3.3.3.2 Environmental Consequences

3.3.3.2.1 Alternative 1 – No Action Alternative

FEMA would not be the Federal action agency; therefore, FEMA would not be required to undertake activities related to compliance with Section 7 of ESA and EFH. However, specific effects on special status species would be considered in the SER following issuance of the final PEA. Because this alternative may involve construction of WWTPs and/or clustered OWNRS, effects on special status species would likely be similar to those under Alternatives 2 and 3 discussed below.

3.3.3.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

Assessing effects on special status species depends on the specific siting of WWTPs as well as their design component details; therefore, effects on protected species and their habitats would be considered as part of the project-specific SER (including all collection and disposal options proposed under this Alternative). In compliance with Section 7 of ESA, FEMA would conduct appropriate consultation, including seeking concurrence for findings of effect, with USFWS and/or NMFS with regards to proposed projects and their potential to impact protected species and their habitats. Mitigation measures developed in consultation with USFWS and/or NMFS during the Section 7 process would become applicant conditions for project implementation.

Additionally, FEMA would conduct appropriate EFH consultation with NMFS in accordance with MSA regulations at the project-specific SER level. To the extent practicable, this coordination would be integrated with Section 7 ESA compliance.

In a letter dated October 1, 2001 pertaining to preparation of this PEA, the Florida Keys Field Office of USFWS recommended that project applicants avoid certain habitat types in siting wastewater management activities (Appendix G). This includes avoiding parcels that have significant areas of tropical hardwood hammock, pine rocklands, buttonwood grasslands, or freshwater marshes. Accordingly, FEMA would require project applicants to consider feasible alternatives that site WWTP facilities outside of these areas as part of preparation of the project-specific SER. Also, in response to preparation of this PEA, both NMFS and USFWS stated support of advanced wastewater treatment facilities in the Keys and the resulting nearshore environmental improvements (Appendix G).

As discussed in Sections 3.3.2.1 and 3.3.2.2 (No Action Alternative and Alternative 2), reductions in the release of nutrients and pathogens to marine habitats would occur under this alternative. A reduction in nutrients and TSS released to the marine water column may benefit seagrass-dependent protected species such as the West Indian manatee and the green turtle by reducing the growth of phytoplankton, improving water clarity and potentially increasing seagrass productivity and growth.

A reduction in nutrients released to marine waters may also benefit coral reef-dwelling species listed for protection, including sea turtles, groupers (*Epinephelus* spp.), and the State-listed pillar coral (*Dendrogyra cylindrus*). As discussed in Section 3.3.2.1, reduced nutrients favor corals by limiting the growth of non-symbiotic mat-forming algae that can out-compete corals.

Questions have been raised regarding a possible connection between chemicals (such as chlorine, by-products, and daughter compounds) and nutrients and a marked increase of Fibropapillomatosis (FP) in sea turtles. The disease is generally characterized by multiple lobe-

shaped tumors (fibropapillomas) ranging from a few millimeters to 25 centimeters in diameter. Juveniles are affected most severely, with half or more of the immature green turtles in some coastal foraging pastures of Florida and Hawaii exhibiting tumors (Balazs, 1997). A herpes virus has been found in more than 95% of the fibropapillomas of green and loggerhead sea turtles in Florida (Klein, 1998), but the exact role it or any other possible etiological (disease-causing) agents play, and the extent to which pollution, genetics, and other factors are involved remains unclear. Thus far, despite numerous studies, no solid link has been established between disease occurrence and the chemicals and other pollutants in question (Aguirre, 1998). Additional information on the Public Health effects of chlorine are in Section 3.6.4.2.1, Public Health.

3.3.3.2.3 Alternative 3 – On-Site Treatment Upgrades

Effects on special status species, and consultation requirements, would be similar to those described in Alternative 2 and would be further developed in preparation of the project-specific SER.

3.4 AIR QUALITY

3.4.1 Affected Environment

The Clean Air Act requires EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to the public health and the environment. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of “sensitive” populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set NAAQS for six principal pollutants, known as “criteria” pollutants: carbon monoxide (CO), nitrogen dioxide (NO₂), ozone (O₃), lead (Pb), particulate matter less than 10 microns (PM 10), and sulfur dioxide (SO₂). The FDEP has two Special Purpose Monitoring stations in Monroe County, one on Stock Island at JR College Road and US Highway 1 and the other in Marathon at 2796 Overseas Highway (FDEP, 1999). These stations only monitor PM 10. The average of the 1-hour maximum recordings in the last 4 years was 46 micrograms per cubic meter (µg/m³) with no exceedances in any year. This is well below the NAAQS 24-hour average standard value of 150 µg/m³.

According to FDEP and EPA acceptable limits on ambient air quality, Monroe County is considered in attainment for all six major principal pollutants (Monroe County, 1997). Counties surrounding Monroe County include Broward, Collier, and Miami-Dade and they are also in attainment. There can be exceptional events (fire or natural occurrences) that would exempt certain areas of Florida from compliance. In the Keys, there is a time of the year when African Dust can be a problem, but thus far, it has not exceeded compliance (Edds, Pers. Comm., 2001).

Table 3-2: Year 2000 Maximum Recorded Criteria Pollutant Levels for Monroe and Neighboring Counties in Florida

County	Pollutant (in parts per million [ppm])						
	SO ₂ Max 24-hr. (.14 ppm*)	Lead Max Quarterly Mean (1.5 µg/m ³)	CO Max 1-hr. (35 ppm)	CO Max 8-hr. (9 ppm)	NO ₂ Max Annual Average (.053 ppm)	Ozone Max 1-hr. (.12 ppm)	PM 10 Max 24-hr (150 µg/m ³)
Monroe	N/A	N/A	N/A	N/A	N/A	N/A	59 µg/m ³
Broward	.031 ppm	05 µg. /m ³	7.5 ppm	4.1 ppm	.010 ppm	.092 ppm	47 µg/m ³
Collier	N/A	N/A	N/A	N/A	N/A	N/A	42 µg/m ³
Miami-Dade	.004 ppm	N/A	8.7 ppm	4.8 ppm	.016 ppm	.100 ppm	54 µg/m ³
Source: FDEP, 2000 – EPA Aerometric Information Retrieval System (AIRS).							

3.4.2 Environmental Consequences

3.4.2.1 *Alternative 1—No Action Alternative*

Monroe County grant applicants would not receive FEMA funds for wastewater management but would still have to meet Florida Statutory Treatment Standards by 2010. The systems upgrades would likely require the operation of heavy equipment during construction and would result in minor temporary adverse effects on air quality from increased exhaust pollutants. Windblown soil and dust may also occur during the construction phase as a result of equipment movement over exposed soil areas. Fugitive dust can be greatly minimized by appropriate dust control measures such as wetting the surfaces, mulch, and by re-vegetating disturbed areas as soon as possible following construction.

3.4.2.2 *Alternative 2 – Centralized Wastewater Treatment Plant*

Minor, temporary, and localized adverse effects on air quality may result from the construction or upgrade of WWTPs. The operation of heavy equipment during construction would result in minor temporary adverse impacts on air quality from increased exhaust pollutants. The new wastewater treatment facilities would result in the ingress and egress of maintenance equipment. Windblown soil and dust may also occur, as described in Section 3.4.2.1, No Action Alternative.

After construction of the proposed facility, daily operations may increase the presence of objectionable odors, such as from hydrogen sulfide. Objectionable odor is addressed in F.A.C. 62-604.400 and 62-296.320. These regulations specify that the project applicant would give reasonable assurance that the facility would not cause odor at such levels that they adversely affect neighboring residents, in commercial or residential areas, so as to be potentially harmful or injurious to human health or welfare or unreasonably interfere with the enjoyment of life or property, including outdoor recreation. In order to mitigate odors, the project applicant would be required to design and implement an odor control system such as hydrogen sulfide or ozone removal system, or use aeration, establishment of buffer zones, or innovative structural design to control odors. The use of specific mitigation measures for odor control would be further developed in the project-specific SER. A Federal (40 CFR Part 63) or State of Florida (F.A.C. 62-210) air permit is not required for existing or newly constructed WWTP unless operating a sludge incinerator (Lucas, Pers. Comm., 2001; Edds, Pers. Comm., 2001).

Collection Option 1 – Vacuum Pumping

The vacuum pumping system aerates odors during the transport sewage to the treatment facility by allowing air into the pump system behind wastewater that has accumulated in holding tanks. The odor in these systems is decreased due to high dissolved oxygen, on the order of 6 to 8 ppm. The only release of air occurs at the vacuum station, which is run through a biofilter before being released. The biofilter removes 99.9% of the hydrogen sulfide (Carney, Pers. Comm., 2001). Temporary adverse effects to air quality may result from construction activities, similar to those described in Section 3.4.2.1, No Action Alternative.

Collection Option 2 – Low-Pressure Grinder Pump Sewer System

Temporary adverse effects to air quality may result from construction activities. These effects are similar to those described above under Alternative 2.

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Disposal Option 1 – Shallow Injection Wells

Temporary adverse effects to air quality may result from construction activities. These effects are similar to those described above under Alternative 2.

Disposal Option 2 – Wastewater Reuse

There is not expected to be any adverse effects of wastewater reuse on air quality.

3.4.2.3 Alternative 3 – On-Site Treatment Upgrades

Impacts related to construction activities would be similar to those described in Section 3.4.2.1, No Action Alternative. The installation of clustered OWNRS systems would require periodic maintenance and subsequently result in a minor increase in the number of vehicles traveling through the area.

A vent stack constructed as part of the OWNRS is normally used to push odors outside and prevent odors from backing up into residences and businesses. Initially, clustered OWNRS may release foul odors from treatment tanks following the first several months of use; however, as bacteria start to reproduce and grow, odors in the system would be reduced (Brookman, Pers. Comm., 2001).

3.5 CULTURAL RESOURCES

3.5.1 Affected Environment

Cultural resources are protected by a variety of laws and regulations, including the National Historical Preservation Act (NHPA) of 1966, as amended, NEPA, the Archaeological Resources Protection Act (ARPA), the American Indian Religious Freedom Act (AIRFA), and the Native American Graves Protection and Repatriation Act (NAGPRA).

Section 106 of the NHPA and implementing regulations (36 CFR 800) outline the procedures to be followed in the documentation, evaluation, and mitigation of impacts for cultural resources. The Section 106 process applies to any Federal undertaking that has the potential to affect cultural resources. The Section 106 process includes identifying significant historic properties and districts that may be affected by the proposed actions or alternatives, and mitigating adverse effects to those properties listed, or eligible for listing, in the National Register of Historic Places (NRHP) (36 CFR 60.4). Historic properties are defined as archaeological sites, standing structures, or other historic resources listed on, or determined potentially eligible for, the NRHP.

The cultural resources of South Florida, including the Keys, are as diverse as the residents of the area today. From the earliest periods of human occupation, the vast natural resources of the Everglades area supported cultures uniquely adapted to a coastal/marsh existence. Although the focus of the PEA is on the Keys, the Florida State Archaeology Plan classifies the Keys as part of the Everglades (FSHPO, 1993).

3.5.1.1 Paleo-Indian Period (ca. 12,000 to 10,000 BP)

The earliest human inhabitants of Florida were Paleo-Indian and entered the region by about 12,000 BP. The Paleo-Indian period is thought to have lasted through 10,000 before present (BP). Paleo-Indians are generally thought to have been hunter-gatherers, who lived a nomadic existence, following game and exploiting seasonally available plant life. Generally, all that remains of Paleo-Indian sites are lithic artifacts including blades, projectile points, and other tools and by-products of tool manufacture. Because of the high acidity of Florida soils, other tools and artifacts made of bone or wood have decomposed. The environment during the Paleo-Indian period was substantially different from that observed today. Based on pollen and fossil evidence, the climate appears to have been much drier (FSHPO, 1993). During this period, the vast glacial ice sheet that covered North America to as far south as Pennsylvania resulted in sea level elevations that were far lower than today. Thus, the Atlantic coast of Florida is estimated to have been 72 to 90 miles east of its present location (FSHPO, 1993). As a result of the subsequent global warming and rising sea level, it is likely that a number of Paleo-Indian sites are now submerged beneath the Atlantic Ocean.

The Florida State Historic Preservation Plan suggests that Paleo-Indian sites that withstood the dramatic environmental shifts of the late Pleistocene period would most likely be found:

- Where erosion has exposed deeper and earlier strata or sediments
- Where sediment accumulation has occurred at a slower rate
- Near sinkholes where deep sediments are exposed to the present surface

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- Along the central Gulf Coast, where sea-level rise has exposed Pleistocene limestone outcroppings (FSHPO, 1993)

The Florida State Historic Preservation Office's Master Site Files database of archaeological sites has only one known Paleo-Indian site, Grass Key Rock Pit site (8MO1297), within the Keys region. Though located some distance from the Keys, the Cutler Fossil Site (8DA2001) in Dade County is considered a significant Paleo-Indian manifestation in the Everglades cultural area.

3.5.1.2 *Archaic Period (ca. 10,000 to 3,000 BP)*

The Archaic period extends from about 10,000 BP through about 3,000 BP. This period is generally characterized by an increase in the diversity of resources exploited. Fishing, hunting, and gathering were all strategies used to procure food. The Archaic period has been divided into three phases by archaeologists, based on stylistic changes in stemmed projectile points and the development of fiber-tempered pottery. The Early Archaic (10,000 – 7,000 BP) is defined by the presence of Dalton, Hamilton, and Kirk-serrated projectile points. The Middle Archaic (7,000 – 5,000 BP) is characterized by the presence of Marion and Putnam projectile points. Finally, Late Archaic (5,000 – 2,500 BP) archaeological sites may possess Clay and Lafayette projectile points, as well as fiber-tempered pottery.

According to the Florida Master Site Files (FMSF) database of archaeological sites, Key Largo 1 (8MO25) has been identified and determined to potentially be Late Archaic. It is the only Archaic Period site listed in Monroe County, and is a multi-component shell midden site. The Cutler Fossil Site (8DA2001) noted above also has evidence of Archaic Period.

3.5.1.3 *Glades Period (ca. 2,500 BP to AD 1500)*

From about 2,500 BP to European contact during the 16th century, the development of diverse cultural traditions occurred throughout Florida. In south Florida, the Glades tradition is divided into many sub-periods based primarily on differences in ceramic decoration styles. Lithic artifacts are sparse in south Florida; chert outcrops are rare, so other materials such as wood, bones, and shells were used to configure tools. Ceramics during the “pre-Glades” period (ca. 2500 BP to AD 1) are normally undecorated (Glades Plain and Goodland Plain) (FDHR, 2001). The Glades I early period (AD 1-500) ceramic type is characterized by quartz sand and grit temper. Later Glades periods (AD 500-1700) included the appearance of punctated, incised, and stamped decoration on pottery, as well as European artifacts during the Glades IIIC period (FDHR, 2001).

The Glades period is characterized by a reliance on shellfish and marine resources, as well as hunting and gathering on the land. Generally, there are four types of Glades period sites: primary habitation, secondary habitation, resources procurement/processing, and mound sites (FSHPO, 1993). Important Glades period sites include the Bear Lake Site (8MO33), Upper Matecumbe Key (8MO17), and Rock Mound (8MO26-27).

3.5.1.4 *Historic Period (ca. Mid-1500s to 1951)*

Spaniards in search of gold, silver, and other natural resources first arrived in Florida in the mid-1500s, marking the beginning of contact that would forever change, and virtually eradicate, Florida's native cultures. Once the Spanish realized that the riches of South and Central America

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were not to be found in Florida, their focus turned to converting the native population to Christianity. Relations with the Timucua, the Guale, and the Apalachee were tumultuous at best, and aspects of this adversarial relationship are reflected in the archaeological record. The building, burning, and rebuilding of missions occurred with confusing frequency (FSHPO, 1993). Chaotic relations between Native populations and Europeans were common throughout the southeast. European trade interests exacerbated difficulties and boundary squabbles. Florida eventually became home to the Seminole Indians, who were comprised of Creek Indians from the north who were fleeing British encroachment in that region. In the Keys, the Tequestas and Calusas, two early south Florida tribes, disappeared before the new Seminole population arrived. The Seminoles continue to inhabit parts of Florida today.

European control of Florida vacillated between the British and Spanish during these early years until Florida became part of the United States in 1821 (FSHPO, 1993). The first settlers to the Keys arrived just a year later in 1822 at the same time that the United States established the Navy Pirate Fleet in Key West. These pioneers were known as “Conchs” and were largely fisherman who also salvaged shipwrecks along the reefs of the Keys. In fact, “the English ‘fisherman’ began to grow wealthy from salvaging wrecked ships...and the shakier characters were helping the salvage business along by stringing lanterns from palm trees, tricking captains into the shallow water reefs” (Florida Keys Virtual Traveler, 2001).

By 1845, Florida gained statehood. During the Civil War, Union forces blockaded Florida’s ports and occupied Fort Zachary Taylor. With the economy already faltering, the end of the war only meant difficulty for industries and their recovery due to the vast destruction to infrastructure and the land. It was not until after World War II that the economy began to rebound and Florida’s “frontier” period ended (FSHPO, 1993). The railroad entrepreneur Henry Flagler helped bring an end to this “frontier” period with his extension of the Florida East Coast Railroad, which extended from Homestead to Key West. Before the rail line’s completion in 1912, transportation in the Keys was exclusive to boats. Unfortunately, the rail line was destroyed in 1935 by the Labor Day hurricane and transportation was again limited to boats (Florida Keys Virtual Traveler, 2001). Today, the Overseas Highway follows the old Florida East Coast Railroad route to Key West and is the Keys’ artery to the mainland.

3.5.1.5 *Monroe County Cultural Resources*

As stated in the Monroe County Comprehensive Plan, there is no specific inventory of historic resources for this area. However, the FMSF has the most complete listing of registered archaeological sites and historic architecture in the State. According to this database, 449 archaeological sites have been identified in Monroe County dating from nearly every time period. In addition, over 1,000 historic structures have been identified within the county. An Internet search of records of the NRHP indicates that there are 37 resources listed for Monroe County, Florida ranging from archaeological districts to individual homes. Finally, although several counties in Florida (such as Duval County) have developed predictive models for locating cultural resources, Monroe County does not currently have such models (Taylor, Pers. Comm., 2001).

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3.5.2 Environmental Consequences

3.5.2.1 Alternative 1 – No Action Alternative

FEMA would not provide funds to Monroe County grant applicants for wastewater management improvements. Thus, the project would not be subject to FEMA Section 106 review for potential effects to cultural resources. Nevertheless, because Alternative 1 would consist of a combination of Alternatives 2 and 3, effects on cultural resources would be similar to those discussed in Sections 3.5.2.2 and 3.5.2.3.

3.5.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

Under this alternative, cultural resources may be adversely affected in areas where new treatment facilities or modifications to existing facilities are made. Adverse effects to historic architectural resources within view of wastewater facilities are unlikely since there are no known historic structures within the viewshed of any of the currently known WWTP sites. Furthermore, buffering around the facilities would likely preclude potential adverse effects of actions proposed under this Alternative.

Though separate from Section 106 requirements, the Florida Administrative Code attempts to mitigate visual effects on adjoining properties by requiring WWTPs to:

“...give reasonable assurance that the facility shall not cause odor, noise, or lighting in such amounts or at such levels that they adversely affect neighboring residents, in commercial or residential areas, so as to be potentially harmful or injurious to human health or welfare or unreasonably interfere with the enjoyment of life or property, including outdoor recreation. Reasonable assurance may be based on such means as aeration, landscaping, treatment of vented gases, buffer zones owned or under the control of the permittee, chemical additions, prechlorination, ozonation, innovative structural design, or other similar techniques and methods, as may be required.” (*F.A.C.*, 1996)

Archaeological resources may be affected by ground disturbing activities associated with the construction of, or modification to these facilities. Proposed activities at each facility should be reviewed for the potential for ground disturbance in previously undisturbed areas. Coordination with the FSHPO should be completed as part of the site-specific SERs prior to any construction activity that involves new ground disturbance.

Collection Options 1 and 2 – Vacuum Pumping and Low Pressure Grinder Pump

These systems require the construction of vacuum stations, and/or associated piping which could result in potential adverse effects to archaeological and architectural resources. Any potential effects are likely to be similar to those described in Section 3.5.2.2, Alternative 2. New construction under these options would have to be reviewed for potential adverse effects to archaeological resources prior to ground disturbance.

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Disposal Option 1 – Shallow Injection Wells

This alternative has similar implications to Alternative 2 as described above, and would likely have similar impacts. Injection wells would be a component of the treatment facility. Potential effects on cultural resources would be evaluated at the project specific SER level.

Disposal Option 2 – Wastewater Reuse

The effects of installing a wastewater reuse system would be similar to those described under Collection Options 1 and 2. This would include limited excavation and laying of pipes. Potential effects to cultural resources are project specific, and as such, would be evaluated in an SER.

3.5.2.3 Alternative 3 – On-Site Treatment Upgrades

Existing on-site systems would be upgraded or replaced with a clustered OWNRS, which requires a relatively small area for each unit. Depending upon the scale of modification required to upgrade these systems and the need for new subsurface pipes, adverse effects to archaeological resources may occur in areas of previously undisturbed ground. Since OWNRS do not involve significant building retrofits and are mostly installed below ground, it is unlikely that historic buildings and viewsheds would be affected. Potential effects of the clustered OWNRS systems on cultural resources would be evaluated further at the project specific SER level.

3.6 SOCIOECONOMIC RESOURCES

The projects proposed for funding are located in Monroe County, which has a population of 79,589 (Y2000) with a **median household income (MHI)** of \$42,283, (Y1999) and **median family income (MFI)** of \$50,734 (Y1999) (U.S. Census, 2000b). The average household size in Monroe County is 2.3 people. According to a comparison of Florida price level indices, Monroe County residents experience the highest cost of living in the State of Florida due, in part, to the desirability of the area to both tourists and residents, relatively high transportation and water delivery costs, limited space for development, and high property values. Monroe County's economic base expanded during the 1980s outperforming the State and the nation in terms of high employment growth, low unemployment levels, and increases in per capita income (Monroe County, 1997). In the 1990s, sprawling populations and the desire for local control led to more cities becoming incorporated. The millions of tourists that visit the county each year provide the major source of employment and financial input to the local economy. Through the mid 1990's, Monroe County's unemployment remained two to three percentage points below statewide and national levels (Monroe County, 1997). The main employment remained the tourist industry, followed by commercial fishing, retail services, and government. In consideration of the major components of the socioeconomic environment and the proposed projects, impact analysis related to tourism, the fishing industry, and local fees and taxes are discussed separately in the following sections.

3.6.1 Tourism

3.6.1.1 Affected Environment

Beautiful natural surroundings, temperate weather, clear waters, cultural diversity, and the world's third largest coral reef system make the Keys popular as both a tourist destination and retirement community. The Keys received about 2.9 million visitors from June 1997 to May 1998 (Leeworthy and Vanasse, 1999). During that period, visitor spending approximated \$1.19 billion with about 60% of that figure spent on goods and services remaining within Monroe County. This translates to an estimated 13,655 jobs in direct employment based on the tourism industry alone, and represents 42% of the total number of those employed in Monroe County.

Because of its heavy reliance on tourism, the local economy fluctuates seasonally. Employment is at its highest level from December to April during the tourist season, steadily declines from May through October, then begins rising again in November. Monroe County's base of income is largely independent of employment due to the importance of the tourism industry and the large population of retired people living in the Keys who are drawing pensions, retirement pay, dividends, and interest on investments, and social security (English, et al., 1996). Cruise ship passengers also represent significant contributors to the Keys' tourism industry. In 2000, an estimated 656,866 cruise ship passengers went through Key West Harbor (Kozma, Pers. Comm., 2001).

Some of the more popular tourist activities include sightseeing and attractions, swimming and beach activities, snorkeling, visiting museums and historic sites, wildlife observation, and, to a lesser extent, personal watercraft use, fishing, scuba diving, and camping (Leeworthy and Wiley,

1996). There is a strong connection between the abundance and diversity of natural resources in the Keys and the value of the tourism industry (Leeworthy and Bowker, 1997).

Tourist populations use hotels, restaurants, marinas, retail stores, and other public places with utility systems, and therefore, include a large portion of the population that contributes to the county's sewage. Thus, tourism is a key factor in wastewater quality and capacity issues. In an analysis of seasonal fluctuations in potable water use, FCAA found a direct relationship between an increase in water use and an increase in the tourist seasonal demand (Cates, 2001).

Inadequate wastewater treatment and disposal has been blamed for posted health advisories throughout the Keys, though no formal beach closures have been recorded (Teague, Pers. Comm., 2001). During the summer of 2000, numerous beaches and canals in the Keys tested positive for **enterococci**, a bacterium whose presence serves as an indicator of fecal pollution. Representatives from the EPA and Monroe County Department of Health identified the cause to be raw sewage escaping wastewater collection systems through storm drain pipes and groundwater flow into nearshore beach waters (Bill Kruczynski, EPA, and Jack Teague, formerly of Monroe County Health Department, in Karnatz, 2000). As of publication of this PEA, no available studies estimate the impact of these beach and water quality advisories on tourism and the local economy (Kozma, Pers. Comm., 2001). Over the past 15 years, the number of tourists has steadily increased; and, in the past 5 years, the population of tourists visiting the Keys has increased at an average yearly rate of about 4% (Kozma, Pers. Comm., 2001). Although health advisories do not appear to be influencing tourism in the Keys, it may be predicted that the periodic health advisories likely affect the use of beaches on a localized scale. Posted health advisories may cause tourists to recreate at alternate beaches that do not have posted health advisories or choose to participate in alternate recreational activities.

3.6.1.2 Environmental Consequences

3.6.1.2.1 Alternative 1 – No Action Alternative

No FEMA funds would be provided to Monroe County grant applicants or applied to wastewater management projects. Alternative funding would be needed to improve wastewater management so that it would comply with Florida Statutory Treatment Standards by 2010.

Depending on the choice of funding vehicle and total assistance funding, the implementation of wastewater management projects may affect local fees and taxes, and may increase tourists' vacation costs. Higher vacation costs may reduce the number or alter the demographics of the visitor population as higher rates may make vacations to the Keys less affordable. A more detailed discussion on the impact of the No Action Alternative on local fees and taxes is discussed in Section 3.6.3.2.1.

The No Action Alternative would improve ground and nearshore water quality and probably reduce or eliminate the number of health advisories in local beaches and canals. The No Action Alternative may increase the number of visitors to beaches that formerly posted advisories, and/or reduce visitor pressure on alternate beaches and recreational activities. This is discussed in detail in Section 3.6.4, Public Health.

Construction activities associated with the implementation of wastewater management projects proposed in the MCSWMP have the potential to result in localized and temporary, adverse effects on tourism. Depending on the location of these projects, traffic may be re-routed or

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tourist attractions may be temporarily closed. Temporary construction activities associated with wastewater management upgrades would be short-term and generally considered part of routine maintenance of facilities. With effective mitigation, such as timing the construction in the off-season, the effects would be negligible.

3.6.1.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

Effects on tourism under Alternative 2 are similar to those described under Alternative 1 in Section 3.6.1.2.1. A more detailed discussion on the impact of Alternative 2 on local fees and taxes is discussed in Section 3.6.3.2.2.

Localized temporary construction effects on tourism and visitors' enjoyment of the Keys would be discussed in the SER prepared to evaluate a site-specific project. The SER would include mitigation measures, such as developing a traffic management plan, to reduce effects on tourism as a result of this alternative. None of the collection or disposal options is expected to impact tourism beyond those effects described in Section 3.6.3.2. Temporary construction activities associated with wastewater management upgrades would be short-term and generally considered part of routine maintenance of facilities.

3.6.1.2.3 Alternative 3 – On-Site Treatment Upgrades

Effects on tourism under Alternative 3 are similar to those described under Alternative 1 in Section 3.6.1.2.1. A more detailed discussion on the impact of Alternative 3 on local fees and taxes is discussed in Section 3.6.3.2.2.

Localized temporary construction impacts on tourism and visitors' enjoyment of the Keys would be discussed in the SER prepared to evaluate a site-specific project. The SER would include mitigation measures, such as recommendations for traffic management plans, to reduce impacts on tourism. Temporary construction activities associated with wastewater management upgrades would be short-term and generally considered part of routine maintenance of facilities.

3.6.2 Fishing Industry

3.6.2.1 Affected Environment

Next to tourism, commercial fishing is the Keys' second largest industry (NOAA, 2000). The dockside value of Monroe County's commercial fishing industry has been estimated at \$55 million annually. This is equivalent to over 20 million pounds of seafood and marine products per year (Table 3-3), (Brown, Pers. Comm., 2001). In a survey of the nation's 60 major commercial fishing ports, Key West was rated in the top ten for overall value in the years 1995 to 2000, but is ranked between 40th and 50th for quantity (NMFS, 2000). There were 1,982 active commercially registered vessels in Monroe County accounting for 2,428 commercial fishing licenses in 2000 (Brown, Pers. Comm., 2001).

Spiny Lobster represents the largest Keys' fishery harvest, at about \$25,600,000 per year based on an average of 1995 to 2000 harvest-value figures. Established in the late 1940's, the Tortugas pink shrimp industry is the second largest fishery business, at about \$6,150,000 annually (NOAA, 1999 and Brown, Pers. Comm., 2001). Large stone crab is the third largest at \$3,860,000 annually (Brown, Pers. Comm., 2001). It is likely the high value of commercial fishing in the Keys is due to the high profitability of the three main harvests: lobster, crab, and

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shrimp. Statistically, fin fishes, such as grouper, tuna, snapper, ballyhoo, and flounder, have fluctuated in harvest, but generally declined by an average of about 9% between the years 1995 and 2000, with an uncharacteristic increase in fin fish in 1999. Harvesting of live rock and live sand, used in decorative aquariums, has also declined, however this is likely due to a ban on harvesting live rock and live sand in Florida State waters (Table 3-3).

Table 3-3: Trends in Monroe County Fishery

Year	1995	1996	1997	1998	1999	2000
Fish (in pounds)						
Fin Fish	7,759,793	7,125,859	6,413,043	6,010,078	6,373,180	5,410,236
Invertebrates ¹	9,719,450	10,116,097	10,060,710	8,839,995	10,610,628	7,858,628
Shrimp	5,313,128	6,388,154	3,695,231	6,156,735	3,968,242	3,425,180
Bait Shrimp	70,597	218,448	86,565	102,190	92,695	117,667
Marine Life Fin Fish ²	123,001	99,930	108,463	119,690	110,199	98,201
Marine Life Invertebrates ³	1,089,559	1,041,728	965,442	1,519,671	1,827,976	2,165,134
Plants	18,908	7,871	9,103	7,911	11,243	10,720
Live Rock/Sand	493,548	119,622	68,114	16,512	21,325	28,406
Total	24,587,984	25,117,709	21,406,671	22,772,782	23,015,488	19,114,172

¹Invertebrates include: crabs, lobster, octopus, sponge, and squid.

²Marine Life refers to landings of live species for the tropical ornamental trade.

³Marine Life Invertebrates include conchs, crabs, jellyfish, lobsters, anemones, snails, stars, urchins, and sanddollars.

Source: Florida Fish and Wildlife Conservation Commission

The commercial and recreational fishing industry in the Keys is regulated through the Gulf of Mexico and South Atlantic Fishery Management Councils, NMFS, and Florida Fish and Wildlife Conservation Commission. Additional information related to federally regulated fisheries, the MSA, and EFH compliance are in Section 3.3.

Changes in vegetation due to water quality problems in Florida Bay have been held responsible for the loss of about \$32 million in the commercial fishing industry between 1986 and 1994 (McPherson and Halley, 1996). Numerous sources have been identified with declines in water quality in Florida Bay, including inadequate wastewater management, stormwater runoff, nutrients and heavy metal contamination from marinas, and the reduction of freshwater flow from the Everglades. As a result, populations of Florida Bay sponges have died, which has impacted harvests of spiny lobster and pink shrimp (McPherson and Halley, 1996). Although there are currently restoration projects being carried out in the Everglades, estimates at this time of project effects on Florida Bay and consequently to the nearshore environment in the Keys would be difficult to quantify. Water quality deterioration in Florida Bay affects the fishing industry because the Bay acts as a fish nursery. Less information exists on the relationship between wastewater management activities and effects on fisheries on the Atlantic-side of the Keys (Beaver, Pers. Comm., 2001).

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3.6.2.2 *Environmental Consequences*

3.6.2.2.1 Alternative 1 – No Action Alternative

Keys Communities would not receive FEMA funds for wastewater management and still would have to meet Florida Statutory Treatment Standards by the year 2010. Keys nearshore marine waters would likely improve as planned wastewater management activities reduce the amount of nutrients and other pollutants entering the marine waters. Because detailed studies related to the impact of septic tanks and cesspit systems on commercial fisheries have not been completed for the Keys, it is difficult to quantify the expected improvement to fisheries associated with meeting the Florida Statutory Treatment Standards. As described in the Water Quality Section 3.2.2.2.1, the replacement of existing cesspits and septic systems with OWNRS systems and centralized WWTPs would greatly reduce the overall nutrient and pathogen inputs to the shallow groundwater of the Keys. Generally, it may be predicted that harvested species that occur in nearshore waters such as spiny lobster, white mullet, gray snapper, various flounder, shrimp, and stonecrab would benefit from improved water quality. In consideration of the cumulative effect of on-going stormwater management activities and other wastewater management activities in the Keys, the benefits may range from relatively insignificant to potentially substantial improvements in harvest rates. These effects cannot account for pollutants from Florida Bay, which would continue to adversely affect commercial fisheries regardless of wastewater treatment improvements in the Keys. As described in Section 4, the Everglades restoration activities would likely assist in decreasing nutrient inputs to Florida Bay.

3.6.2.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

FEMA would provide funding to aid in the construction or upgrade of community and regional WWTPs throughout the Keys. Effects on commercial fishing due to the use of WWTPs are similar to those described in Section 3.6.2.2.1. None of the collection or disposal options is expected to impact fisheries beyond the effects described in Section 3.6.2.2.1.

3.6.2.2.3 Alternative 3 – On-Site Treatment Upgrades

FEMA would provide funding to Monroe County grant applicants to upgrade OWTS to OWNRS to improve wastewater management in the Keys. Effects on commercial fishing due to the use of clustered OWNRS are similar to those described under Alternative 1 in Section 3.6.2.2.1.

3.6.3 Local Fees and Taxes

3.6.3.1 *Affected Environment*

Monroe County residents must pay county, State, and Federal taxes. County taxes vary depending on the specific community within Monroe County; however, the average property tax for all districts in Monroe County is 13.4% of the appraised property value, not including property tax deductions such as the homestead exemption (Monroe County, 2001b). Several taxing bodies within Monroe County affect the total millage rate that composes the property tax. Depending on the district, these taxing bodies may include the Monroe County School District; law enforcement, jail, and judicial system; mosquito control project; local health clinic; fire and ambulance district; local city tax authority; and county general fund. Additionally, the SFWMD levies property taxes from Monroe County residents for the Everglades and Lake Okeechobee

projects that provide watershed management and water supply protection for the Keys' potable water resources.

Monroe County has a 7.5% sales tax (1.5% county and 6.0% State). Additionally, the County's residents, businesses, and visitors pay Florida State taxes, including insurance premium, estate, fuel, gross receipts utility, dry cleaning, coastal protection, water quality, inland protection, hazardous waste, and tourist development taxes; infrastructure, education, indigent care, and charter county transit surtaxes; and rental car, waste tire, lead acid battery, and audit and warranty fees and surcharges. The State of Florida does not impose a personal income tax; however, it does levy a 5.5% corporate income tax. Residents and businesses are subject to Federal taxes.

3.6.3.1.1 Existing Wastewater Management Costs in Monroe County

For the purpose of this PEA, wastewater management cost discussions may include reference to: 1) **system capital costs** which include expenses associated with planning, designing, engineering, purchasing, building, and installing a wastewater treatment system, and its needed wastewater conveyance piping in public right-of-ways and selected effluent disposal method (e.g. injection wells, SDI, reuse); 2) **abandonment and lateral costs** which include the expenses associated with removal and disposal of the existing wastewater treatment system, and piping on service recipient's property for connection to a new system; and 3) **operation and maintenance (O&M) costs** for the system. Each of the above costs may be combined into a monthly rate structure, where the system is administered by a utility, which would include amortization of some costs, as detailed in the discussion.

Five basic types of wastewater systems are presently used in Monroe County: cesspits, septic tanks, on-site ATUs, OWNRS, and centralized WWTPs. The OWNRS and some of the WWTPs are already compliant with Florida Statutory Treatment Standards. Wastewater costs associated with them are addressed in Section 3.6.3.2, which discusses the consequences of implementing wastewater management improvements that meet Florida Statutory Treatment Standards.

Almost all Keys' cesspits are at residences that were built before 1970. From discussions with wastewater service companies in the Keys, it was gathered that "properly" functioning cesspits (i.e., those that drain and leach out effluent into the surrounding soil and subsurface limestone) do not need to be pumped out; and consequently, do not have any associated operation and maintenance costs. As most of them were installed over 30 years ago, there are also currently no associated system capital costs. Cesspits are currently illegal to install in Monroe County, and are being removed as part of Monroe CIEGP. This program is discussed in detail in Section 3.6.3.2.1.

Septic systems are prevalent in Monroe County, for both homes and small businesses. Septic systems collect sewage in a tank and allow the liquid waste to filter through the drainfield into shallow soils and subsurface limestone. For septic systems in working condition, pumping to remove solid waste is only needed about every six to ten years (D and D Enterprises, Inc., Pers. Comm., 2001). The cost to pump a standard size septic tank of 1,000 gallons is about \$300, equating to an approximate annual cost of \$38 or a little over \$3 a month (assuming pumping every 8 years).

Many new or recently built homes and some large residential wastewater generators (e.g., resorts, motels, RV parks, trailer parks) in Monroe County use non-compliant ATUs to treat

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waste. Currently, these systems handle only a very small percentage of the total amount of wastewater generated in the Keys. Non-compliant ATUs clarify the waste stream, but do not meet the Florida Statutory Treatment Standards; therefore, they are consequently only approved for use until 2010. ATUs require either an injection well or an SDI for disposal of the treated wastewater and the FDH requires that users hold an active maintenance contract.

The system capital cost for a non-compliant ATU is about \$7,800, with roughly \$3,000 comprising the cost for either an injection well or an SDI (equivalent cost for both). If this system capital cost is amortized over 20 years at 6% interest, this equates to a monthly cost of \$56. Additionally, a two-year maintenance contract costs about \$400, or \$17 per month. In total, a non-compliant ATU system has an approximate system capital and O&M cost of \$73 per month per **equivalent dwelling unit (EDU)**. This system capital cost is lower if more than one EDU shares the purchase and installation cost of an injection well (even the smallest wells can handle flow from at least 3 EDUs), but because there are many social and legal complications associated with this, injection wells are not commonly shared (Sears Aerobic Service, Pers. Comm., 2002).

Today, there are five local utility-operated WWTP systems, two of which are compliant with Florida Statutory Treatment Standards. The service recipients on these systems are charged for the initial connection costs in addition to a monthly sewer bill. Total monthly wastewater management rates for the three non-compliant systems that do not meet Florida Statutory Standards are shown in Table 3-4 below and range from \$55 to \$64, assuming the capital, abandonment, and lateral costs are amortized over 20 years at 6% interest. If paid in lump sum at the time of connection, connection costs for Key Haven Utilities, Ocean Reef Club, and K W Resort Utilities are \$1,215, \$2,400, and \$2,700, respectively. Public authorities regulate all utility companies that provide centralized sewer service. The private companies in the Keys are regulated by the Florida Public Service Commission (FPSC). Consequently, all wastewater management rates charged by private companies are authorized by the FPSC and any proposed annual rate increases go through a public commission review and approval process before being implemented.

Table 3-4: Average Monthly Operation and Maintenance Costs and Total Rates for Non-2010 Compliant Monroe County WWTPs Per EDU

Utility Company	System Capital Cost	Average Monthly O&M Wastewater Cost	Average Total Monthly Wastewater Rate ¹
Key Haven Utilities	\$1,215	\$48	\$56
Ocean Reef Club	\$2,400	\$46	\$64
K W Resort Utilities	\$2,700	\$35	\$55

¹ including system capital, abandonment, and lateral cost amortized at 6% interest, over 20 years; March 2002 figures

The following table summarizes monthly wastewater management costs relative to each wastewater system, as well as, the information source of each cost parameter.

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Table 3-5: Estimated Monthly Costs per EDU for Non-Compliant Wastewater Systems

Wastewater System	System Capital Cost	Operation and Maintenance Cost per Month	Total Cost per Month¹	Source
Cesspit	\$0 ²	\$ 0 - \$3	\$0 - \$3	Mitchell Enos Septic Tank Corp., 2002 Sears Aerobic Service, 2002
Septic System	\$0 ²	\$3 - \$4	\$3 - \$4	Synagro and Accurate Enterprises of South Florida, Inc., 2001
Interim ATU	approx. \$7,800	approx. \$17	approx. \$73	Sears Aerobic Service, 2002
WWTP	\$1,215 - \$2,700 ³	\$35 - \$48	\$55 - \$64	Pers. Comm. with Key Haven Utilities, Ocean Reef Club, and K W Resort Utilities

¹ including system capital costs amortized at 6% interest over 20 years; March 2002 figures

² assumed to be already paid for

³ includes abandonment and lateral costs

3.6.3.1.2 Wastewater Management Costs and Affordability for Florida Keys Residents

Of particular importance is the question of what constitutes fair and affordable wastewater management costs for Keys residents and businesses. Although not specifically addressing wastewater utility rates, many Federal and State agencies have set affordability standards for utility service at a particular percentage of MHI. This is an acceptable method of affordability determination if the household's income is relatively close to the median. However, this method would give false conclusions regarding affordability if the household income being used is significantly below the median or if the cost of living is so high that discretionary income is very small. For this reason, the discussion of wastewater rate affordability in this analysis is separated into affordability analysis of near median-income populations (presented below) and low-income populations (Section 3.8, Demographics and Environmental Justice).

In order to assess wastewater rate affordability and reasonableness, a representative minimal financial situation was considered to determine the approximate average monthly living expenses for a household of two adults and one child in Monroe County (Table 3-6).

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Table 3-6: Estimated Average Monthly Costs for Household Expenses in the Florida Keys

Average Monthly Expenses (Household of Two)	Estimated Cost per Month	Source
Rent / Mortgage	\$1,248	Census, 2000
Food	\$356	USDA, 2001
Electricity	\$95	City Electric, 2001
Water	\$30	FCAA, 2001b
Telephone	\$21	Bell South, 2001
Wind and Flood Insurance	\$200	Johnson's Insurance Company, 2002
Incidentals (clothing, medical, etc.)	\$100	Assumed Cost for Purpose of Analysis
Total	\$2,050	

The cost of a monthly rental or mortgage payment in the Keys was based on the estimated nation wide figure of one third of household income going towards lodging expenses. Though it is known that 10.5% of Keys residents pay over one third of their income on housing, it is not specifically known how much more they are paying; and consequently, the value of \$1,248 is a conservative estimate (Pers. Comm., Casey, 2002). The costs shown for food, water, telephone, insurance and incidentals are best-guess estimates of average costs from the sources cited. City Electric's estimate for an average per month was \$95 for about 1,000 kilowatt-hours. FCAA estimates potable water costs at an average of \$10 per person per month based on \$4.93 per 1,000 gallons. The monthly expenses do not include wastewater rates that renters or homeowners may be paying at present. It should be noted that the expenses listed above are basic, and do not include other potential monthly costs such as transportation expenses.

To determine the approximate discretionary income for median income households, the 2001 MHI figure of \$44,948 per year (inflated from the 1999 Census-2000 figure) can be converted to a monthly value of \$3,746. Net monthly income is \$3,184 after subtracting federal tax rate of 15%. With the total basic monthly expenses subtracted, the result is a discretionary income of \$1,134 for a household with an income near the median in Monroe County.

The question of what wastewater management cost amount should be considered reasonable and affordable for a household with a discretionary income of \$1,134 per month is difficult to answer definitively. The EPA uses a figure of 2.0% of MHI as its threshold of affordability for drinking water projects (EPA, 1993b). The U.S. Department of Housing and Urban Development uses a range of 1.3% to 1.4% of MHI to determine household affordability for water and sewer bills (cited in EPA, 1998). The National Consumer Law Center recommends less than 2.0% for water and sewer bills (cited in EPA, 1998). Many states have developed multi-tiered affordability criteria, listing different percentages of MHI for different income brackets. The State of Pennsylvania uses a sliding scale of 1.0% to 2.0% of MHI for water rates, depending on the socioeconomic condition of the community (cited in EPA, 1998). The State of New York uses three price levels of 1.0%, between 1.0 and 1.5%, and 1.5% of MHI for drinking water prices for three delineated income groups (cited in EPA, 1998).

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Table 3-7 shows a selection of monthly wastewater management rates for domestic users throughout the U.S. for October 2001 and their corresponding percentage of the monthly MHI for that county. (Note: All figures represent either 1,000 gallons/month usage or minimum flat rate costs, either with 5/8 inch meter size.)

Table 3-7: Selection of Monthly Wastewater Management Rates for Cities in Florida Cities and Across the U.S.

City and State	Average Monthly Sewer Bill 2001	% of county monthly 2001 MHI	Source
Sanibel, FL	\$31.52	1.00%	FKAA, 2002
Marco Island, FL	\$31.52	0.84%	FKAA, 2002
San Diego, CA	\$29.81	0.82%	http://www.sannet.gov
Rochester Hills, MI	\$10.88	0.20%	http://www.rochesterhills.org
Aiken, SC	\$20.63	0.59%	http://www.aiken.net
Fairbanks, AK	\$39.98	0.93%	http://www.state.ak.us
Cocoa, FL	\$17.51	0.52%	http://www.cocoafl.org
Amarillo, TX	\$6.21	0.24%	http://www.ci.amarillo.tx.us
Kent, WA	\$19.75	0.42%	http://www.southcountyjournal.com
Silverton, OR	\$44.03	1.30%	http://www.silverton.or.us
Settler's Bay, AK	\$10.85	0.23%	http://www.state.ak.us

This sample of rates shown in the table above is not meant to be representative of the whole country, but to illustrate that wastewater management rates vary greatly. Many of these rates are influenced at least in part by the users, in public forums, where the issue of affordability is debated. They are also strongly influenced by the sophistication of the systems (e.g., the level of treatment of the wastewater) and the age of the infrastructure that the utility companies must maintain.

With a MHI of \$3,746 per month in Monroe County, it can be seen that the common maximum affordability criteria of 2.0% or \$75 per month is only 6.6% of monthly discretionary income (at \$1,134 per month). For households in Monroe County that have incomes close to the county's MHI, a wastewater rate of near 2.0% of MHI appears to be affordable. Given the very complex connections between the Keys economy (e.g., tourism and fishing), residents' quality of life, and water quality, residents with incomes close to the median would potentially be more willing and able to pay for upgrades to wastewater treatment than other users around the United States, whose economy and surrounding environment may not receive as apparent benefits from their wastewater system upgrades.

3.6.3.1.3 Wastewater Management Costs and Affordability for Keys Businesses

Commercial wastewater management rates are often slightly higher than domestic rates for the same area. This is because utility rate regulators generally assume that businesses are "for profit" and are able to bear more financial burden than residents. When determining wastewater cost affordability for commercial businesses, a number of questions arise. How much of an increase

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in cost can an individual business withstand? Can the business pass on the increased cost of wastewater to the consumers of its goods or services? Will the increased cost threaten the existence of the business? If so, what will be the impact on the local community if the business goes out of service? The answers to these questions depend on what type of business is being examined, the labor and economic conditions of the community that the business serves, the quantity of effluent produced, and the financial condition of the business in question.

Although medium and larger businesses could likely afford wastewater cost increases, corporations with branches or stores in Monroe County may look unfavorably at lower profit margins and decide to move to a more profitable location. Small businesses may be able to survive price increases by lowering wages or charging more for their services, but already small profit margins or elastic demand for goods or services may not allow for much of a price increase (Note: A good or service has an elastic demand when the quantity demanded is responsive to price changes. For example, fewer people would use a car wash if the price goes up by 50 cents a wash). Businesses that would inevitably be hit the hardest would be those that are high wastewater generators, like laundromats and car washes.

3.6.3.2 Environmental Consequences

3.6.3.2.1 Alternative 1 – No Action Alternative

No FEMA funds would be used for wastewater management projects in Monroe County. In order to become compliant with Florida Statutory Treatment Standards, wastewater system owners would have to use alternative funding sources to upgrade or construct community or regional WWTPs, and/or install OWNRS.

Table 3-8 below presents the wastewater management costs for the compliant systems in use in Monroe County that were not recipients of FEMA funding; however, they were recipients of other sources of funding.

Table 3-8: Approximate Monthly Costs for Existing 2010-Compliant Wastewater Systems per EDU

Wastewater System	System Capital Cost	Operation and Maintenance Cost per Month¹	Total Cost per Month²	Source
WWTP³				
Key West	\$1,600	\$36	\$46	Key West, 2002
Key Colony Beach	\$4,550	\$30	\$68	Key Colony Beach, 2002
OWNRS⁴	\$2,500 ⁵ – \$8,200 ⁶	\$45 ⁵ - \$59 ⁶	\$63 - \$118	Sears Aerobic Service, 2002, Monroe County, 2000a

¹ March 2002 figures

² Including system capital costs amortized at 6% interest, over 20 years; March 2002 figures

³ Does not include abandonment and lateral costs. Does include cost of new piping up to property edge and connection to WW system

⁴ Includes abandonment costs. Assumes 4 EDUs on system. Does not include purchase cost of the land on which the system would reside.

⁵ Cost estimated by Sears Aerobic Service, 2002

⁶ Cost taken from Monroe County, 2000a for Four Home Shared OWNRS

The design, construction, and operation of systems that meet Florida Statutory Treatment Standards to serve all currently non-compliant systems represent an enormous cost. Monroe County estimates that the total capital cost of the identified improvements to serve all of the county's wastewater service areas is \$438 million (Monroe County, 2000a). In the absence of federal, state, and local grant funding, the capital costs for a single centralized WWTP system could range from \$14,000 to \$17,000 per EDU for a service area of 300 to 550 EDUs (Shelby, Pers. Comm., 2002). Numerous funding and financing options exist including user fees and charges; taxes and assessments; bonds and loans; grants and contributions; redirection of existing programs or funding; and financial assistance. The FKAA and Village of Islamorada have identified potential grant funding sources external to FEMA funding at the time of publication of this PEA as described in Table H-1 in Appendix H. These options and potential sources of funding are described more fully in Appendix H. The choice of funding vehicle may also be determined by the Monroe County BOCC, FKAA, or local jurisdictions (Shelby, Pers. Comm., 2001).

Though not currently available, funding recently existed to assist in converting cesspits to OWNRS. The Monroe County's CIEGP provided grants through the Monroe County Department of Health that covered 62% or more of the capital cost of OWNRS systems. Individuals with cesspits were eligible for the program, as well as a group of residences that were interested in sharing an OWNRS system. Program administrators indicated that only a very small number of users had expressed interest in sharing a system, but that a few shared systems were funded. As of March 2002, the program had exhausted all of its funds, but administrators were optimistic that new funds would be allocated and that the program would be continued and eventually expanded to target users with septic systems also. It is interesting to note that none of the households that received aid from the CIEGP chose to install a SDI system for wastewater disposal (Pers. Comm., Sleighter, 2002).

Economic effects of the No Action Alternative on local wastewater management costs or taxes are difficult to quantify beyond the above information, because they would depend on the final costs of the system improvements, the number of individuals served, the amount of State and Federal grants and contributions, the details of the chosen financing options, including applicable repayment terms, and set affordability thresholds. However, as a group, owners of cesspit or septic systems are likely to see the greatest increase in costs over their present wastewater management expenses. Project-specific effects would be further evaluated in the SER.

In the event that wastewater system owners/operators do not comply with wastewater regulations, FDEP and FDH can initiate non-compliance enforcement action. For WWTPs under FDEP jurisdiction, penalties can range from warning letters to fines of \$10,000 per day, until system compliance is reached (Rios, Pers. Comm., 2001). Although enforcement action has not been defined, the FDH has jurisdiction over smaller WWTPs and on-site systems (Bibler, Pers. Comm., 2001). Furthermore, the DCA may retain 20% of unincorporated Monroe County's building permits as a non-compliance enforcement action (Lazar, Pers. Comm., 2001).

3.6.3.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

FEMA would provide funding for the construction of new community and regional WWTPs, and treatment upgrades to existing centralized systems at selected locations in the Lower, Middle, and Upper Keys. As described in Section 1.4, Monroe County has an obligation to meet more stringent treatment standards regardless of proposed FEMA funding. However, the availability of

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FEMA funds to reduce capital costs of proposed WWTPs would reduce the financial burden to the Monroe County government and service recipients. Although discussed below, FEMA funds would not be applied towards the long-term monthly O&M costs, which would be the responsibility of service recipients.

Similar to Alternative 1, the impact of Alternative 2 on local fees and taxes is difficult to quantify because it would depend on the final costs of the system alternatives, the number of individuals served, the amount of other State and Federal grants and contributions, and the details of the chosen financing options, including applicable repayment terms. Actual project costs and funding structure would be discussed in more detail, as needed, in the project specific SER whereby economic impacts can be better quantified in relation to affordability thresholds presented in this PEA. However, wastewater management projects receiving FEMA funding would not be expected to greatly exceed the affordability threshold of 2% of MHI (approximately \$75 per month) described in Section 3.6.3.1.2., as detailed below. The impact of these rates on low-income households is discussed in detail in section 3.8.1.4.

As an example, FCAA is currently building a centralized WWTP that will serve the Little Venice community without FEMA funding. The projected cost of this WWTP is over \$7.2 million and FCAA has received an EPA grant for \$4.35 million. The remaining \$2.85 million in costs will be passed on to the service recipients as a system development fee. This system development fee will be split into two parts. The first part is a one-time charge of \$4,700 per EDU. The \$4,700 can either be paid up front in full or paid annually through a non-ad valorem property tax assessment of \$473 for ten years. The second part is a monthly cost of \$25, which will be called a monthly capital cost. This monthly capital cost of \$25 will be added to the monthly operation and maintenance cost, which will also be around \$25, for a total monthly rate of approximately \$50 (Teague, Pers. Comm., 2002).

Considering the costs of completed or in-progress wastewater management projects and preliminary estimates for planned projects, the costs to service recipients, once funding assistance has been applied, are expected to range as follows. The system capital costs are generally expected to range between \$3,000 and \$4,500 per EDU. The abandonment and lateral costs are generally expected to range between \$1,500 and \$5,000 per EDU. The monthly O&M costs are generally expected to range between \$30-\$60 per EDU (Shelby, Pers. Comm., 2002; Islamorada, 2001c). Incorporating the system capital, abandonment, and lateral costs into the monthly O&M costs gives a monthly range of \$63 to \$128 per EDU. While the actual costs to service recipients are expected to fall within this range, most are expected to incur a monthly cost near the commonly used 2 percent of MHI affordability threshold or \$75 per month. Costs to service recipients beyond these ranges may be considered unreasonable.

Table 3-9: Approximate Centralized WWTP Costs

	System Capital Costs	Abandonment and Lateral Costs	O&M Costs	Total Monthly Costs
Initial Costs	\$3,000 - \$4,500	\$1,500 - \$5,000	n/a	n/a
Monthly Cost at 6% over 20 yrs	\$22 - \$32	\$11 - \$36	\$30 - \$60	\$63 - \$128

Under Alternative 2, abandonment and lateral costs would be an important issue to those users who have already paid for or are currently paying for wastewater systems. Users who have installed non-2010 compliant systems could face continuing monthly payments on financed capital costs for systems (or parts of systems) that are obsolete. The situation that would be facing users who currently have 2010-compliant systems has yet to be determined, but mandatory hook-up to the central WWTP, even without use, could be required. The impacts to these users, including effects on businesses that have recently purchased on-site systems, would be further examined in the project-specific SERs, as needed.

Collection Options 1 and 2

Regardless of which collection option is selected, local wastewater costs would likely increase. The extent of increase would depend on the rate structure and financing details. The rate structure may be all-inclusive or the service recipient may be required to separately pay abandonment and lateral costs associated with conveying wastewater from the residence/business to the street wastewater piping.

Disposal Option 1 – Wastewater Injection wells

Effluent disposal costs are part of the system capital costs and are built in to the corresponding rate structure.

Disposal Option 2 – Wastewater Reuse

Under the wastewater reuse disposal option, capital costs are generally more expensive than with alternative disposal methods, such as injection wells, because of the additional effluent pumps, storage tanks, generators, distribution pumps, and distribution piping required to convey treated effluent to the disposal sites. Therefore, this alternative may have higher system capital and O&M costs, and may result in even higher wastewater management costs as these are distributed to service recipients. However, the distribution of costs associated with this disposal option depends on the destination of reused wastewater. As described in Section 2.3.2.2.2, reused wastewater may be employed for a variety of purposes. Accordingly, recipients of reused wastewater would likely incur most of the conveyance costs.

As an example, the Village of Islamorada considered wastewater reuse for several proposed WWTPs within its service area. The results of the analysis found that the establishment of wastewater reuse infrastructure could add additional monthly costs per EDU ranging from \$5.50 to \$19.75, depending on how many properties within the Islamorada service area would receive treated effluent (Islamorada, 2001b).

The SERs would evaluate project specific cost effects for this disposal option.

3.6.3.2.3 Alternative 3 – On-Site Treatment Upgrades

FEMA would provide funding assistance to project applicants for the conversion of OWTS to clustered OWNRS, thereby reducing the financial burden to service recipients.

As shown in Table 3-8, if an OWNRS system is shared by four EDUs, the cost would range from \$2,500 to \$8,200 with a monthly cost of \$63 to \$118, which includes operation and maintenance costs and amortized system capital costs. Under Alternative 3, FEMA would help fund the use of

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these systems in clustered arrangements with the actual number of EDUs per cluster to be determined at the project-specific level. In addition, costs to larger wastewater generators, such as businesses, would potentially be reduced from those shown in the table, by the purchase of larger capacity systems, thus benefiting from economy of scale.

The actual wastewater management costs per EDU as a result of on-site treatment upgrades are difficult to quantify because they would depend on the final system capital costs, the number of EDUs served per cluster, the amount of State and Federal grants and contributions, and the chosen financing options. In addition, the cost of the land on which the system would be installed would need to be accounted for. With the availability of FEMA funds to substantially reduce the system capital costs and/or abandonment and lateral costs of a clustered OWNRS, the monthly wastewater costs to service recipients are not expected to greatly exceed the 2% of MHI (\$75 per month) affordability threshold described in Section 3.6.3.1.2. More specific details on costs and taxes relative to the installation of OWNRS systems would be included in the project-specific SERs.

3.6.4 Public Health

3.6.4.1 Affected Environment

FDH maintains a wide range of public health statistics for the 67 counties in the State of Florida. Monroe County ranks highest in the State of Florida for Acquired Immune Deficiency Syndrome (AIDS) per 100,000 persons for the period 1998 to 2000 (FDH, 2001b). Hepatitis A ranks fourth, but examining all **enteric** diseases, which includes campylobacteriosis, shigellosis, salmonellosis, giardiasis, and Hepatitis A, Monroe County is in the bottom third of total counties for incidents of infections per 100,000 persons for the period 1998 to 2000. Monroe County ranks less than the State average for Hepatitis B for the period 1998 to 2000, and there are no known cases of Cholera in the last ten years. In 1999, the major cause of death in Monroe County was cancer, at 714 persons (FDH, 2001b).

Contaminated water in Monroe County has led to many beach closings/advisories in recent years. In 1999, there were 30 days with either a beach closing or advisory with the number jumping to 60 days in 2000 (EPA, 2001b). There has been evidence of microbial indicators of sewage pollution such as fecal coliform, *Enterococci*, and *Clostridium perfringens* in the nearshore and offshore waters throughout the Keys (Paul et al., 1995a; Paul et al., 1995b; Paul et al., 1997). These enteric microbes were linked to septic tanks and cesspits in several recent studies. In one study, viral tracers placed in shallow Class V injection wells in Key Largo and the Middle Keys appeared in 8 to 11 hours in ground water and 23 to 53 hours in marine waters (Paul et al., 1995b; Paul et al., 1997).

In another study, none of 19 sites tested throughout the Keys violated ambient water quality standards for fecal coliform. However, 79% of the sites tested positive for the presence of enteroviruses, 63% of sites tested positive for Hepatitis A, and 10% of the sites tested positive for Norwalk viruses (Griffin et al., 1999).

The influx of polluted water from on-site systems to groundwater, canal, and nearshore marine waters varies seasonally. In one study, nutrient concentrations of groundwaters were twice as high during the winter compared to summer, while nutrient concentrations of surface waters

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were twice as high during the summer. The increased pollution to inland and nearshore waters was attributed to the higher maximum tides and increased hydraulic head during the summer, wet season, which increases the rate of exchange between groundwaters and inland and nearshore waters (Lapointe et al., 1990). The movement of microbes is expected to follow this pattern of increased flow from groundwater to nearshore water during the summer months and decreased flow during the winter months.

The presence of enteric microbes in canals and nearshore marine waters can pose a health risk if ingested while swimming or eating contaminated seafood (Paul et al., 1995a, Caffry, Pers. Comm., 2001). A study published in June 2000 estimates that about one third of the participants in the 23rd Annual Swim Around Key West event held on June 12, 1999 reported at least one illness as a result of swimming in contaminated nearshore marine waters (Nobles et al., 2000). This was based on a total of 192 respondents (55%) out of 350 race participants. As part of the study, the researchers collected water samples over a four-day period and found that levels of *Enterococcus* and fecal coliform ranged from low to extremely high levels over that period. Although the study did conclude that demonstrable health effects were related to poor water quality around the Key West area, the reliability of its conclusion has been called into question because swimmers were asked to recall health effects suffered five months after the swim event occurred. An additional study conducted in the United Kingdom in 1998 assessed the severity of illnesses associated with swimming in recreational waters contaminated with domestic sewage. This study found that an average duration of illness ranged from about 4 to 8 days, 4.2 to 22.2% of those affected sought medical treatment, 7.0 to 25.9% reported loss of at least one day of normal daily activity, 34.5% experienced gastroenteritis and 65% of the participants experienced ear infections (Fleisher et al., 1998 as cited in Nobles et al., 2000).

It should also be noted that fecal coliform is not considered a truly viable indicator of human sewage because it is found in dogs, birds, and other animals, and there have been cases where fecal coliform has been isolated in tropical waters far from human contact (Griffin et al., 1999). In comparison to four other counties in southern Florida, Monroe County ranks third in cases of enteric disease counts per 10,000 population and 1,000 children under 6.

Table 3-10: Enteric Disease Counts of Monroe and Neighboring Counties (1999)

	Monroe	Collier	Dade	Broward
Reported Cases per 10,000 population	4.12	9.39	4.90	3.50
Reported Cases per 1,000 children under 6 years of age	1.61	4.95	2.25	1.57
Source: Florida Department of Health, 2001				
Note: Statistics are based on reported cases only and do not likely include tourists that may represent a high proportion of transient beach users in Monroe County				

3.6.4.2 Environmental Consequences

3.6.4.2.1 Alternative 1—No Action Alternative

Without FEMA funds for wastewater management, Monroe County project applicants would still have to reach Florida Statutory Treatment Standards by 2010. It is likely that water quality conditions nearshore and offshore, as this relates to public health, would improve but at a slower rate than with FEMA funding. The available data does not conclusively demonstrate instances of infection or health problems specifically related to groundwater or offshore contamination caused by present sewage treatment practices. However, as described in Section 3.6.4.1, studies indicate the presence of viruses and bacteria associated with human sewage; therefore, it may be assumed that public health risks exist.

If this alternative were chosen, the potential for public health risks would continue in the short term due to a possible lag in upgrading sewage treatment systems. However, the health risk for bacteria and viruses would presumably decline with the implementation of specific wastewater treatment processes. Shallow injection well use would include biological treatment, such as an Immersed Membrane Bioreactor (IMB) process, which disinfects effluent through the addition of liquid chlorine or UV disinfection, and has demonstrated a virus removal effectiveness of greater than 99.99% (Islamorada, 2001a). There are two specific levels of disinfection as defined by FDEP: basic disinfection and high-level disinfection. As defined in chapter 62-600 of the F.A.C., Regulations of Domestic Wastewater Facilities, basic disinfection results in water with no more than 200 fecal coliform values per 100 ml of sample, while high-level disinfection results in water with fecal coliform values below detectable limits per 100 ml of sample. In compliance with F.A.C. 62-600, shallow injection wells (Class V) are required to meet high-level disinfection requirements.

Health concerns have been raised regarding the use of liquid chlorine for the disinfection of wastewater. Nevertheless, only about 30 of the centralized domestic wastewater treatment facilities in the State of Florida use UV radiation as their primary disinfection method, and the remaining 2,500 employ chlorination (Sawicki, Pers. Comm., 2002). Although it is a hotly debated topic, chlorine has not been found to cause cancer in animals and is not classified by the EPA or U.S. Department of Health and Human Services for carcinogenicity (EPA, 1994b and EPA, 1994a, and Dunnick et al., 1993). However, byproducts such as trihalomethanes (THMs), which are formed as a result of chlorination, have been linked to an increased risk of bladder and rectal cancer (EPA, 1994d; Komulainen et al., 1997; Dunnick, 1993; Morris et al., 1992). The EPA has known since the 1970s that THMs, specifically chloroform, are carcinogenic to animals (FDEP, 2001b). Because of the known risks, THMs are closely regulated and monitored by FDEP and EPA. Under Florida regulations (F.A.C., Rule 62-550.514), community water supply systems that serve at least 10,000 people are required to monitor total trihalomethanes (TTHMs) quarterly (FDEP, 2001b). According to David York, Coordinator of Florida's Wastewater Reuse Program, there has not been a major problem with THMs; on average, he sees a 50/50 split between plants violating THM limits and those not reaching the limit (York, Pers. Comm., 2002). In general, the State of Florida concedes in its Administrative Code that it is aware of the risks associated with chlorination and even encourages the use of alternative disinfection methods (FDEP, 2001c).

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3.6.4.2.2 Alternative 2 – Centralized Wastewater Treatment Plant

FEMA would provide funding for upgrade or construction of new community and regional WWTPs at select locations throughout the Keys. With FEMA funding, the project applicant would likely be able to improve wastewater conditions at a more efficient rate.

It is expected that risks to public health would be reduced. The centralized WWTP would eliminate the use of cesspits and septic tanks within the service area, which contribute to bacterial and viral contamination to nearshore and offshore waters. However, the extent of improvement is difficult to determine due to the lack of available data related to groundwater or nearshore marine contamination, and the actual benefits of replacing cesspits and septic tanks. Even without specific data, the health risk for bacteria and viruses is expected to decline greatly with the implementation of wastewater treatment processes that meet Florida Statutory Treatment Standards. The level of disinfection depends on the method of disposal and is further discussed below.

Collection Options 1 and 2

Either option would provide beneficial impacts such as those described in Section 3.6.4.2.1.

Disposal Option 1 – Wastewater Injection wells

Injection wells permitted as Class V require high-level disinfection under F.A.C. 62-600.540. To achieve this level of disinfection, the WWTP would include biological treatment, such as an IMB process that disinfects effluent through the addition of liquid chlorine or ultraviolet light and has demonstrated a virus removal effectiveness of greater than 99.99% (Islamorada, 2001a). Treatment to this level of disinfection would effectively reduce sewage-related public health risks for that service area.

Disposal Option 2 – Wastewater Reuse

Selection of this disposal option is not expected to result in long-term adverse effects on public health because the effluent would comply with FDEP regulations and F.A.C. 62-600 and 62-610 that require basic or high level disinfection depending on application before being used in a public setting. Effluent disinfection would likely be accomplished through the use of chlorine or UV treatment (Teague, Pers. Comm., 2001).

3.6.4.2.3 Alternative 3 – On-Site Treatment Upgrades

Under Alternative 3, OWTS such as cesspits and septic tanks with drainfields would be converted to clustered OWNRS to improve wastewater management. The construction of the OWNRS would eliminate the use of cesspits and septic tanks, which contribute to bacterial and viral contamination to nearshore and offshore waters (Paul et al., 1995a). Under FDH regulations and F.A.C. 64-E6, systems that treat effluent quantities less than 10,000 gpd and use shallow injection wells are required to disinfect effluent by chlorination or some other disinfection method approved by FDH. Clustered OWNRS that dispose of quantities of effluent in excess of 10,000 gpd through injection wells are regulated through FDEP and are required to meet high-level effluent disinfection. Compliance with these regulations would effectively reduce sewage-related public health risks for that service area.

3.7 DEMOGRAPHICS AND ENVIRONMENTAL JUSTICE

EO 12898 (Environmental Justice) requires Federal agencies to make achieving environmental justice part of their mission. Agencies are required to identify and correct programs, policies, and activities that have disproportionately high and adverse human health or environmental effects on minority and low-income populations. EO 12898 also tasks Federal agencies with ensuring that public notifications regarding environmental issues are concise, understandable, and readily accessible. Socioeconomic and demographic data were studied to determine if minority or low-income persons have the potential to be disproportionately and adversely affected by the alternatives.

3.7.1 Affected Environment

3.7.1.1 Population and Race

Monroe County has a permanent population of about 80,000 people. It comprises an approximately 997-square-mile area that includes the communities of Key Largo, Tavernier, Bay Point, the Village of Islamorada, and the Cities of Marathon and Key West. Key West has a population of about 25,000 people, approximately 32% of the total county population (U.S. Census, 2000a). Between 1990 and 2000, the population of Monroe County increased 2%, while the population of the State of Florida increased 23.5% during the same time (U.S. Census, 2000a). Population density in the Keys is estimated to be about 79.8 persons per square mile. For comparison, the average population density in the State of Florida is estimated to be 296.4 persons per square mile (U.S. Census, 2000a).

Because of the large number of visitors to the Keys, the functional population consists of both permanent and seasonal residents. Monroe County estimated the sum of seasonal and permanent residents to be about 159,000 people, which represents the maximum number of people in the Keys on any given evening (Monroe County, 2000b). The functional population of the incorporated and unincorporated areas of Monroe County is expected to increase by an average of about 4% between 2000 and 2010 (Table 3-11), to approximately 165,000 people.

Table 3-11: Functional Population of Monroe County (1990-2015)

Year	Functional Population	Numerical Change	Percent Change
1990	149,348	*	*
1995	154,255	4,907	3.29%
2000	159,113	4,857	3.15%
2005	162,041	2,929	1.84%
2010	164,769	2,727	1.68%
2015	165,366	597	0.36%
Source: (Monroe County, 2000b)			

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In a comparison study of the counties of the South Florida region (i.e., Broward, Miami-Dade, and Monroe), Monroe County had the lowest rate of growth at 2% compared to 29% and 16% for Broward and Miami-Dade Counties, respectively. The City of Key West ranked 36 out of 59 municipalities in the South Florida region in terms of absolute population growth with a 2% rate of growth between 1990 and 2000 (SFRPC, 2001). Additional information pertaining to projected growth, land use, and planning is in Section 3.10.

Of the total population of Monroe County, 90.7% identified themselves as White, 4.8% Black or African-American, 0.4% American Indian and Alaska Native, 0.8% Asian, 1.5% of other race, and 1.8% of two or more races. About 15.8% identified themselves as persons of Hispanic or Latino origin. For comparison, of the total population of the State of Florida, 78.0% identified themselves as White, 14.6% Black or African-American, 0.3% American Indian and Alaska Native, 1.7% Asian, 0.1% Native Hawaiian and Other Pacific Islander, 3.0% of other race, and 2.4% of two or more races. About 16.8% identified themselves as persons of Hispanic or Latino origin (U.S. Census, 2000a).

As part of preparation of this PEA, a spatial analysis using Geographic Information Systems (GIS) was conducted to determine the geographical distribution of minority populations in Monroe County (Figure 3-8). U.S. Census Blocks within Monroe County were evaluated for the percent of the population that exceeded 22% persons of non-white ethnicity (i.e., populations that exceed the average percent of minorities for the State of Florida at-large). Additionally, Census Blocks that had populations exceeding 50% persons of non-white ethnicity were identified as areas where non-white populations composed the majority of the population.

One Census Block in the City of Marathon has a population that is greater than 22% minorities. Several Census Blocks in Key West area also have minority populations that are greater than the Florida State average of 22% non-white persons. Two Census Blocks in Key West have populations that are more than 50% of non-white ethnicity.

3.7.1.2 Income and Poverty

According to the 2000 Census, the 1999 MHI for Monroe County was \$42,283 (U.S. Census, 2000b), which was about 13% greater than the MHI for the State of Florida (U.S. Census, 2001a). Of the total Monroe County population in 1999, approximately 10.2% of individuals fall below the U.S. Census Bureau's poverty threshold (U.S. Census, 2001b). This poverty threshold is set for the entire nation and, with the exception of Hawaii and Alaska, is not adjusted for local cost-of-living deviations. For the year 2001, the poverty threshold was set at \$13,738 for a household of three people (U.S. Census, 2001b). In an area like the Keys where the cost of living is higher than the national average, \$13,738 buys less than elsewhere, effectively making a household near the poverty threshold in the Keys poorer than the same household in an area where the cost of living is lower. In fact, according to the Monroe County Housing Authority, which uses HUD MFI-based income levels to administer its assistance programs, surviving in the Keys at such a low income is almost impossible (Casey, 2002).

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FIGURE 3.8 – MINORITY STATUS

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Accordingly and pursuant to EO 12898, FEMA has adopted HUD's income levels for its low income assistance programs, as they are administered by the Monroe County Housing Authority for the purpose of evaluating and mitigating FEMA-funded wastewater project economic effects on low-income populations. *Low-income* is defined as less than 80 percent of MFI and *very-low-income* is defined as less than 50 percent of MFI. In 2002, MFI was estimated at \$55,100, *low-income* was \$39,650 and *very-low-income* was \$24,800. Appendix J contains additional information on the HUD income limits for the *very-low-* and *low-income* designations.

Before adopting HUD's income levels, consideration was given to the policy/methodology used by other federal agencies, such as the U.S. Department of Health and Human Services, U.S. Environmental Protection Agency, and U.S. Department of Energy; to determine low income ability-to-pay and levels of assistance. There are several important advantages to using the income indicator chosen. First, the dollar value of MFI is already projected (calculated) and published by the Department of Health and Human Services (HHS) on an annual basis. Second, MFI is calculated at the county level and incorporates the Keys's economic demographics. And lastly, the county level MFI is published with adjusted values for various family sizes and qualification standards and is currently used by the Housing Authority and the Department of Health for their assistance programs.

Finally, because the most apparent effect on a low income population is economic in this case, it is more appropriate to use the individual household rather than a 'population' as the unit used for discussion. An individual low income household within a project service area would incur project effects and consequently would trigger compliance with EO 12898, for FEMA funded wastewater projects. The typical approach under EO 12898 is to identify a relatively larger low income 'population' in proportion to an affected area's population demographics, to discuss project effects.

3.7.1.3 *Wastewater Management Costs and Affordability for Keys Lower-Income Residents*

Section 3.6.3.1.2 describes wastewater management costs and establishes an affordability threshold (near 2% of MHI) above which costs may be considered unaffordable and unreasonable. This affordability threshold should be applied to households in the Keys whose incomes approximate Monroe County MHI; however, it is not appropriate for determining what constitutes affordable wastewater management costs for households with incomes much below the median.

For purposes of administering Federal housing assistance to low-income families, HUD has established a set of income limits that designate three income levels below the median. These levels use MFI instead of MHI and are designated as *low-income*, *very-low-income*, and *30% of MFI*. To administer their programs more accurately, HUD makes annual projections of MFI by county and adjusts for family size.

The Monroe County Housing Authority currently uses the first two tiers of the HUD income limits to administer its local assistance programs and notes that, in Monroe County, very few families fall into the lower tier. The Housing Authority notes it is almost impossible to survive financially in the Keys at such low incomes, therefore people in those tiers typically choose to live in other counties.

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Table 3-12: Discretionary Income of Low-Income Residents – 2001/2002

MFI for family of three	Yearly Income	Monthly Net Income ¹	Estimated Average Monthly Expenses ²	Monthly Discretionary Income
<i>Low-Income</i>	\$39,650	\$2,808	\$2,050	\$758
<i>Very-Low-Income</i>	\$24,792	\$1,756	\$2,050	\$0
¹ Net income incorporates 15% Federal tax rate				
² See Table 3-6				

Table 3-11 above shows the 2002 HUD income levels for a family of two adults and one child in Monroe County (HUD, 2002). These limits, already adjusted by HUD for family size, are taken directly from the table of income limits published by the agency annually. The table illustrates that a household of three at the *low-income* level has a discretionary income of \$758 a month after basic expenses, the *very-low-income* level a discretionary income of \$0 a month. As noted in Section 3.6.3.1.2, these basic expenses do not include other potential monthly costs such as transportation expenses. Although these figures are very rough estimates, they support the Housing Authority's determination that the cost of living in the Keys is prohibitively high for families below the *very-low-income* designation. It is likewise clear that unmitigated additional wastewater management costs would result in a highly disproportionate and adverse economic impact to the low-income service recipients.

Environmental Consequences

3.7.1.4 Alternative 1 – No Action Alternative

The project applicants would not receive FEMA funding to help meet Florida Statutory Treatment Standards by the year 2010. As described in Section 3.6.3, Local Fees and Taxes, implementation of the No Action Alternative has the potential to result in higher wastewater management costs than would be expected with the benefit of FEMA funding.

Given the assumptions stated in Section 3.7.1.3, households at or below the *low-income* level would incur financial hardship if wastewater management costs increase to levels that approximate the affordability thresholds of 2% (\$75/month). If unmitigated, increased wastewater management costs would disproportionately and adversely affect *low-income* populations, as the increased financial burden would represent a greater percentage of their discretionary income in comparison to service recipients whose incomes approximate the median.

Monroe County came to this same conclusion when analyzing the impact of increased wastewater management costs on the community of Little Venice. Given the FKAA's future estimated monthly costs for wastewater service, Monroe County concluded that the cost increase would cause a major financial hardship on *low-income* and *very-low-income* households. In order to help mitigate the impacts of this cost increase, the Housing Authority has applied for and received Federal grant money through HUD's Community Development Block Grants. To determine how best to allocate the money among *low-* and *very-low-income* service recipients,

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the Housing Authority will be conducting a door-to-door survey of household income levels in the Little Venice community. As of March 2002, survey results were not complete, and no allocation formula had been decided upon (Berard, Pers. Comm., 2002).

As described in Section 3.6.3.1, some funding recently existed to assist in converting cesspits and septic tanks to OWNRS through the Monroe County CIEGP. This program provided grants that covered 62% or more of the system capital costs. Residents whose homes had an assessed value of less than \$100,000 received an additional grant of \$3,000 (over the 62% grant amount), or about 84% of the total system capital cost of an OWNRS. Those with homes assessed between \$100,000 and \$200,000 received an additional grant of \$1,000, or 69% of the total system capital cost of these systems (Monroe County, 2000a). Although this funding has run out, the county hopes to have more funding available in the near future. Most important to note is that this program is only available to homeowners and may not offset potential increased costs to renters.

Funding to assist low-income households with meeting wastewater treatment standards is also available from State and Federal agencies, and additional funding may become available through new grants and initiatives before the Florida Statutory Treatment Standards take effect in 2010 (Smith, Pers. Comm., 2001). Additional sources of assistance may include the Florida State Revolving Fund and the Florida Department of Community Affairs (DCA) Community Development Block Grant program (Smith, Jetton, Pers. Comm., 2001). Beyond the programs discussed above, Appendix H contains a list of funding options, some of which could be tailored to assist low-income households. The exact contribution from these funding sources would depend on the final costs of the system improvements, the number of individuals served, the total amount of State and Federal grants and contributions, and the details of the chosen financing options, including applicable repayment terms.

The implementation of wastewater management projects under the No Action Alternative would likely result in water quality improvements to shallow aquifers, canals, and nearshore marine waters. The reduction of fecal contamination and nutrient pollution would likely reduce adverse effects on public health. Low-income and minority populations are expected to benefit from these wastewater management improvements to the same degree as other demographic populations in the Keys. No disproportionately high or adverse effects to minority populations are anticipated, unless they are also low-income, which is discussed above.

Although the No Action Alternative has the potential to result in disproportionately high and adverse impacts to low-income populations, FEMA would not be the Federal action agency; therefore, FEMA would not be required to undertake activities related to compliance with EO 12898.

3.7.1.5 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

The project applicant would construct new or upgrade existing WWTPs at selected locations in the Keys. As described in Section 3.6.3, Local Fees and Taxes, implementation of the Centralized Wastewater Treatment Plant Alternative has the potential to result in higher wastewater management costs. Potential effects on low-income and minority populations would be similar to those described under the No Action Alternative. No disproportionately high and adverse effects to minority populations are anticipated. This alternative would similarly affect the entire service area population, regardless of demographics, unless minorities are also low-income, which is discussed above. The physical siting of WWTP and other wastewater facilities

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is not expected to cause highly disproportionate or adverse effects to minority and/or low-income populations in the Keys. Noise and visual resources impacts associated with the siting of WWTPs are expected to be negligible as discussed further in Section 3.11. Unmitigated increased wastewater management costs to low-income service recipients as a result of this alternative would cause disproportionately high adverse effects.

In light of EO 12898 and NEPA, the following low-income household assistance guidelines would apply to FEMA-funded projects. This assistance would be in addition to the basic economic benefit the service area's population would receive from the grant award.

In developing these guidelines, emphasis was placed on the use of available local economic data, practical implementation for FEMA applicants, applicability to the various proposed projects, and consistency with programs.

The guidelines specify the basic qualifying criteria and amount of Federal assistance available to service area residential applicants and is based on HUD's *very-low-income* and *low-income* levels. The balance of wastewater management costs would be paid by the service recipient. The assistance is for system capital costs and lateral costs only. No assistance is provided here for the monthly operation and maintenance costs, as these are long-term cost-of-living expenses. An example of the guidelines can be found in Appendix J, along with the HUD income limits for Monroe County for 2002.

The qualifications for the assistance guidelines are:

- Property Owner(s) must verify ownership of the residential property.
- Property Owner(s) must verify that the property has qualified (or application made) for eligibility for Florida's Homestead Exemption for declaration of primary residence.
- Property Owner(s) must verify qualified family income is within the established HUD MFI as either *very-low-income* (0 to 50% of MFI) or *low-income* (50 to 80% of MFI).

Assistance Guidelines

Income Levels	Amount of Assistance
<i>Very-low-income</i> Qualified Family	90% of System Capital Costs
<i>Very-low-income</i> Qualified Family	90% of Existing System Abandonment costs and private property lateral installation up to an allowance amount of \$3,000
<i>Low-income</i> Qualified Family	70% of System Capital Costs
<i>Low-income</i> Qualified Family	70% of Existing System Abandonment costs and private property lateral installation up to an allowance amount of \$3,000

It should be noted that the above guidance is a minimum level of assistance that FEMA applicants would be required to achieve to mitigate adverse effects on low-income households. The applicants, at their own discretion, may further reduce these costs. Additionally, where

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extreme conditions exist related to abandonment costs and/or private property lateral installation costs create extraordinary hardship for qualifying low-income households, the FEMA applicants shall establish a contingency fund to further reduce costs.

In light of the above assistance guidelines, additional wastewater management costs from Alternative 2, exclusive of monthly O&M costs, are not anticipated to result in highly disproportionate and adverse effects to qualifying low-income households. It should be noted that low-income renters in the service areas may be highly and disproportionately adversely affected if landlords increase rents to cover additional wastewater management costs. Although FEMA does not have specific requirements under EO 12898 to assist low-income renters, they may seek remedy through locally available assistance programs, such as the Monroe County Housing Authority. In the project-specific SER, effects on low-income populations in the service area would be further considered as needed.

3.7.1.6 Alternative 3 – On-Site Treatment Upgrades

The project applicants would upgrade the selected service area's existing on-site wastewater treatment systems by installing clustered OWNRS serving multiple EDUs. This alternative also would require compliance with EO 12898 because of FEMA funding. As with Alternative 2, no disproportionately high adverse effects to minority populations are anticipated since service recipients would be similarly affected, regardless of demographics. However, if minority populations are also low-income, they could incur disproportionately high adverse effects if costs are unmitigated. The physical siting of clustered OWNRS is also not expected to cause highly disproportionate or adverse effects to minority and/or low-income populations in the Keys. Noise and visual resources impacts associated with the siting of clustered OWNRS are expected to be negligible as discussed further in Section 3.11.

As described in Section 3.6.3, Local Fees and Taxes, implementation of this alternative has the potential to result in wastewater management costs that are higher than present, and possibly even higher than Alternative 2. Accordingly, and based on the ability-to-pay information presented in Section 3.7.1.3, adverse economic effects to low-income households in the service areas could be even more disproportionate than those described under Alternative 2. However, the availability of FEMA funding under this alternative would reduce the cost of wastewater treatment improvements to service recipients. Moreover, the additional assistance guidelines for low-income households outlined in Section 3.7.1.5 would also apply under this alternative. The qualifying criteria, and type and level of assistance would be the same. Consequently, highly disproportionate adverse effects to qualifying low-income service recipients are not anticipated from this alternative; however, as described in Alternative 2, low-income renters could incur disproportionately high costs under this alternative.

3.8 HAZARDOUS MATERIALS AND WASTES

3.8.1 Affected Environment

Hazardous Waste is defined by RCRA as a solid waste, or combination of solid wastes, which because of quantity, concentration, or physical, chemical, or infectious characteristics, may cause, or significantly contribute to, an increase in death rate or an increase in serious irreversible, or incapacitating reversible, illness or pose a substantial present or potential hazard to human health and the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Although defined as a solid, according to RCRA, a solid waste can be a solid, a semi-solid, a liquid, or a contained gas (EPA, 2001b). Waste is considered hazardous if it is found in the list published in the 40 CFR Part 261. If it is not identified on the list, it may be hazardous if it is ignitable, corrosive, reactive, or toxic.

Hazardous materials and wastes are regulated in Florida via a combination of federally mandated laws and region-specific laws developed by FDEP Division of Waste Management, Bureau of Solid and Hazardous Waste. The hazardous waste statutes are part of the Florida Public Health section, Chapter 403, Resource Recovery and Management. Portions of Title 40 CFR Parts 260-271 are incorporated into F.A.C. Rule 62-730.

Monroe County has three hazardous materials collection centers located at Cudjoe Key Transfer Station, Key Largo Recycling Yard, and Long Key Transfer Station. Most wastewater sludge and septic waste generated in the Keys is currently hauled to one of three transfer facilities. They do not accept explosives, asbestos, biohazards, or radioactive wastes. Wastewater sludge is not disposed of in the Keys (Bergin, Pers. Comm., 2001). From these transfer stations, the sludge is hauled to a regional wastewater treatment facility in Miami-Dade County for treatment and eventual disposal to a remote agricultural land application site.

New State regulations pertaining to all forms of wastewater solids disposal, except landfilling, took effect in 1998. These regulations mirror the 40 CFR Part 503 Sewage Sludge Regulation published in 1995 by the EPA. Both sets of regulations address pathogen reduction, vector attraction reduction, and heavy metal limits. The regulations specify two alternative levels of pathogen reduction: Class A or Class B. Class A biosolids (i.e., WWTP residual solids that have been stabilized and made into a product that can be beneficially recycled) can be applied via bulk application to public access areas, including private lawns and home gardens; Class B biosolids are prohibited from such application. Both Class A and Class B biosolids can be applied to agricultural land, but more stringent site restrictions are imposed when Class B biosolids are applied. Phase I Environmental Site Assessments would be completed at each project site to characterize the recognized environmental conditions before construction activities ensue. For WWTP project sites, a Phase I Environmental Site Assessment would be conducted in accordance with American Society of Testing and Materials (ASTM) standard E 1527-97. The Phase I Environmental Site Assessment is to visually identify and record any obvious existing, potential, or suspect conditions resulting from the use, handling, and disposal of hazardous substances at the site or adjacent site(s), which may pose an environmental liability to, or restrict the use of, the subject property. A Phase I Environmental Site Assessment would be conducted for each site as part of the SER, and the presence and risk of hazardous materials would be evaluated based on specific site conditions and proposed designs.

3.8.2 Environmental Consequences**3.8.2.1 Alternative 1 – No Action Alternative**

No hazardous waste impacts are expected because hazardous waste is not allowed in the sewage waste stream. However, there may be environmental conditions (e.g., leaking underground storage tanks) at the sites selected for WWTP construction or OWNRS upgrades that could result in adverse effects if not remediated prior to ground-disturbing construction activities. The potential for this impact is unknown. Wastewater sludge waste from the Keys would continue to be hauled to a transfer facility and taken to a wastewater treatment facility in Miami-Dade County for treatment.

3.8.2.2 Alternative 2 – Centralized Wastewater Treatment Plant Alternative

FEMA would provide funding to aid in the construction of new community and regional WWTPs throughout the Keys. With the help FEMA funding, the project applicant would likely be able to improve wastewater conditions at a more efficient rate.

For WWTPs with capacities of about 100,000 gpd or less, decanted sludge would be temporarily stored in an aerated holding tank on-site, and the liquid sludge would be hauled by truck to one of the three Monroe County Solid Waste Transfer Stations. Miami-Dade has committed to accepting increased loads and has the capacity to accommodate the expanded waste quantity from Monroe County (Williams, Pers. Comm., 2001).

For larger WWTPs, the sludge would be processed through belt filter press dewatering, Class B lime stabilization, and then the dewatered cake would be hauled to a remote agricultural land application site outside of Monroe County, in the Lake Okeechobee area of South Florida, as per MCSWMP. This would be beneficial if processed and applied to agricultural land by reducing the amount disposed in landfills.

Effluent is tested once a month and a licensed operator is required to report any WWTP operating problems immediately. Hazardous materials that enter a WWTP are likely to be caught immediately by monitoring stations as required by FDEP regulations (Rios, Pers. Comm., 2001).

The most common hazardous materials that enter the systems are grease and typical household cleaning products (Rios, Pers. Comm., 2001). Inadvertent disposal of hazardous wastes in wastewater effluent is more likely to occur in smaller plants than larger plants because the materials are usually more diluted in the larger plants. Hazardous material that enters a WWTP has the potential to kill the biological component that treats the waste, and is normally pumped out and sent to a larger treatment plant for reprocessing. There are three programs administered by FDEP: Conditionally Exempt Small Quantity Generators, and Regulated Small Quantity Generators and Large Quantity Generators that were created to educate the public and give detail on what is hazardous waste. The FDEP is implementing these public education programs to reduce the potential for hazardous materials to enter wastewater effluent.

One chemical compound associated with wastewater effluent that has been of recent concern is nonylphenol. Nonylphenol is a degradation product of a surfactant widely used for commercial and industrial purposes such as detergents, herbicides and cosmetics and the manufacturing of plastics, textiles, agricultural chemicals and paper. Nonylphenol formation from nonlyphenol ethoxylates can occur through wastewater treatment and in natural environments (Maguire, 1999). The EPA is currently

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in the process of developing aquatic life criteria for nonylphenol (EPA, 2002). Once the criteria is finalized, proposed wastewater systems would be required to comply with State processing and monitoring standards, as applicable. Before formal rules are established, the project applicant would be required to coordinate with FDEP to implement any monitoring protocols that were deemed necessary.

Collection Options 1 and 2

FEMA may fund the purchase of lands required for new pump stations and piping right-of-ways. Prior to acquiring properties, a Phase I Environmental Site Assessment would be completed, as part of preparation of the SER, to determine whether any recognizable environmental hazardous material and/or waste exist at or around the site(s). These results and recommended remedial and/or mitigation measures would be presented in the SERs.

Disposal Option 1 - Shallow Injection Wells

Wastewater injection well effects would be similar to those discussed in Section 3.8.2.1.

Disposal Option 2 - Wastewater Reuse

Reuse systems require full storage or backup disposal systems whenever treatment requirements are not met (Monroe County, 2000a). Since a certain treatment standard must be met before treated effluent would be applied, this option is not expected to result in the release of or effect on hazardous materials.

3.8.2.3 Alternative 3 – On-Site Treatment Upgrades

OWTS such as cesspits and septic tanks with drainfields would be converted to clustered OWNRS to improve wastewater management. This system proposes biological nitrogen removal coupled with a physical/chemical phosphorus removal system and either a shallow injection well or SDI. The potential effects of inadvertent hazardous materials disposal are discussed under the environmental consequences of Alternative 2 in Section 3.8.2.2.

Septic tank sludge from the clustered OWNRS would continue to be hauled to a transfer facility and then hauled to a WWTP in Miami-Dade County for treatment and disposal for eventual agricultural land application in compliance with disposal regulations promulgated by FDEP.

3.9 INFRASTRUCTURE

3.9.1 Traffic and Circulation

3.9.1.1 Affected Environment

The Keys consist of many islands connected by 42 bridges along over 100 miles of US Highway 1. This is the main road in the Keys and functions as an arterial, collector, and Main Street. US 1 is the most important road in Monroe County but there are several smaller roads serving the local communities. US 1 is about 112.5 miles long in Monroe County, with about 19 miles of bridges, extending from Dade County border to Fleming Street in Key West. About 108 miles and 41 bridges of US 1 run through areas that are unincorporated. US 1 and South Roosevelt Boulevard are the only State-maintained roads in Monroe County. The county maintains about 450 miles of secondary roads, including 1.6 miles of bridges that link US 1 to the residential areas. The Florida Department of Transportation (FDOT) classifies all public roads based on the type of service the road provides, found in Chapter 335.04 of the Florida Statutes. The roads are classified into three categories: arterial, collector, and local (Monroe County, 1997).

Traffic capacity limitations are found along four segments of US 1. The conditions of the roadway are based on levels of service (LOS). This is defined by the 1985 Highway Capacity Manual as a qualitative measure describing operational conditions within a traffic stream, and their perception of motorists. Roadway LOS is ranked from A (the best) to F (the worst), with C being the average. Plantation, Upper Matecumbe Key, Lower Matecumbe Key, and Big Pine Key did not meet LOS C and are considered to be critical growth constraints. The improvements needed vary and include: widening roads, restriping to provide more left lanes, traffic signal re-timing, fencing to control Key deer crossing, and highway overpasses and underpasses to facilitate safe Key deer movement (Monroe County, 1997). A reconstruction of an 18-mile stretch of US 1 starting in Miami-Dade to Monroe County has been planned (Molins, Pers. Comm., 2001). Also along US 1, the Jewfish Creek Drawbridge will be replaced with a high-level fixed-span bridge and the installation of culverts to improve the tidal flow to the surrounding wetlands (Monroe County, 2001a).

The largest improvement scheduled by the county is the Card Sound Project. Card Sound Road connects with North Key Largo to the Mainland and is an alternative route to US 1. The road currently is affected by flooding due to unusually high tides. The project is proposed to raise and widen the road, which will also serve as a hurricane evacuation route (Monroe County, 1997). Monroe County currently does not have any plans for new roads. Construction activities in the foreseeable future include bridge repairs and resurfacing along County Route 905 and Card Sound Road (Capell, Pers. Comm., 2001).

Another form of transportation is the use of canals in the Keys for recreational boat traffic. 95% of all marinas and boat dock facilities in Monroe County are privately owned. These facilities provide over 90% of the saltwater slips and moorings in the County. As described in Sections 1 and 3.2, canal water has been negatively affected by nutrient pollution and fecal contamination as a result of inadequate wastewater management facilities in the Keys.

There is limited public transportation throughout Monroe County. The only public transit system is based in Key West. This is a bus service operated by the Key West Port and Transit Authority (PATA). This bus runs from downtown Key West to Stock Island, known as the “Conch Loop” (Monroe County, 1997). There are about 40 miles of off-road bike and pedestrian paths in Monroe County (Monroe County, 1997). In the next five years additional bike paths are planned for several locations.

Environmental Consequences

3.9.1.1.1 Alternative 1 – No Action Alternative

Construction traffic would temporarily increase during the implementation of wastewater management projects; however, any impacts would be minimal since improvements would likely take place on a small scale and over a long period of time. Although FEMA does not have regulatory responsibility over non-FEMA funded projects, it would be expected that funding and/or permitting agencies would require the development and implementation of traffic control plans. These plans would include specific information about temporary traffic control, alternate routes, staging area locations, and optimal working times to minimize traffic disruption. With the transition to new wastewater systems that meet Florida Statutory Treatment Standards, the water quality of canal waters would be expected to improve thereby benefiting the owners and users of canal boating facilities. Other impacts from Alternative 1 would be similar to those explained below in Alternatives 2 and 3.

3.9.1.1.2 Alternative 2 – Centralized Wastewater Treatment Plant

The new wastewater treatment facilities would temporarily increase the traffic to and from each facility due to construction depending on capacity and operations. Due to temporary and/or partial road closures, traffic would increase near the proposed facility and would be expected to last up to 18 months, depending on the scope of work, from the start of construction. It would be expected that a traffic control plan would probably be developed and implemented as described in Alternative 1. Any traffic and circulation effects are expected to be short-term in nature and minimal. Additional information related to traffic and circulation would be in the project-specific SER.

Collection Options 1 and 2

The installation of pumping systems would have temporary, localized adverse impacts on traffic in the Keys. Trenches for piping would be up to 5 feet wide along road right-of-ways, detours of one or two blocks or temporary road closings are expected. FDOT permitting is necessary where road cuts are to be made, but authorization can be obtained locally. During construction activities, vehicular traffic would increase in some areas with the ingress and egress of construction equipment.

The WWTP facility would require piping over navigable waterways (such as along the underside of existing bridges) to connect to residences. Any impacts associated with the construction of the piping, however, would likely be minimal and temporary for waterway traffic because boats would still be able to pass under bridges during construction, where applicable.

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Disposal Option 1 -- Shallow Injection Wells

The installation of new shallow wastewater injection wells is not expected to have notable impacts on transportation network in the Keys, as the wells would likely be built next to the WWTP to minimize piping costs. Traffic may temporarily increase in some areas due to temporary partial road closures requiring two lanes of traffic to use one lane of a road during well construction, but the impact should be minimal.

Disposal Option 2 – Wastewater Reuse

Possible adverse effects of Disposal Option 2 on traffic and circulation would be the aforementioned delays due to the laying of new pipe as discussed above under collection options. The specific details of the impacts of installing reused-water pipes for transport to points of use would be discussed in the project specific SER.

3.9.1.1.3 Alternative 3 – On-Site Treatment Upgrades

Construction traffic would temporarily increase during the upgrade from OWTS to OWNRS; however, impacts would be minimal since improvements would likely be on a smaller scale. Though local roads would primarily be impacted by on-site treatment upgrades, it is expected that the development and implementation of a traffic control plan would be necessary as described in Alternative 1.

3.9.2 Utilities and Services

3.9.2.1 Affected Environment

The Monroe County Division of Public Works provides service in solid waste, public facilities maintenance, engineering, fleet management, and county road and bridge maintenance. Monroe County Public Works does not provide utility services but works closely with utility companies when planning, designing, constructing, or inspecting projects (Monroe County, 1997).

The Florida Keys Electric Cooperative (FKEC) purchases electricity from Florida Power and Light and supplies it to residents of Monroe County east and north of the Seven-Mile Bridge (Monroe County, 1997). During the year 2000, FKEC had 30,034 accounts at a density of 38.15 customers per square mile (FKEC, 2000). This translates to about 788 miles of linear power lines. There are six substations and 126 employees (FKEC, 2000). The average monthly electric bill is \$80.58, and equates to about 1,000 kilowatt-hours (FKEC, 2000). Key West City Electric Services (CES) generates electricity and supplies it to residents west and south of the Seven-Mile Bridge (Monroe County, 1997). The major gas companies in the Keys include Suburban, Amerigas, and Homestead Gas. These companies all provide primarily propane gas to businesses and homes (Monroe County, 1997). Propane gas systems have pipes underground that run from a tank on the property up to the business or home.

In 1937, the Florida State Legislature created the FCAA. The FCAA is the provider of potable water for all Keys residents, and the average monthly water cost is \$20 per household. Potable water is transported to the Keys from the mainland through a 130-mile transmission pipeline, with an additional 649 miles of distribution pipelines that deliver water to the customer's property (FCAA, 2001). The potable water supply resources used by Monroe County are obtained from wells tapping the Biscayne aquifer in Miami-Dade County, entirely outside of

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Monroe County's jurisdiction. No new wells have been permitted in the Keys since 1986, which would limit utilization of underground brackish/saline resources in the Keys as a potential potable water resource. The FKAA has primarily focused on potable water until environmental concerns started to arise regarding wastewater issues (FKAA, 2001). The *2010 Comprehensive Plan* required that Monroe County complete a Sanitary Wastewater Master Plan for the entire unincorporated area of the county. The FKAA has an agreement with Monroe County to identify priority areas and establish treatment plant sites (FKAA, 2001). The FKAA then has legal jurisdiction to purchase, construct, manage, and operate sewage collection, treatment, and disposal services to any entity or area of the county (Monroe County, 1997). The cities of Key West and Key Colony Beach also operate their own regional wastewater systems independent of the FKAA. Islamorada plans to implement its own wastewater infrastructure.

3.9.2.2 Environmental Consequences

3.9.2.2.1 Alternative 1 – No Action Alternative

Long-term adverse effects to utilities and services are not expected. With the coordination of wastewater management activities with public utilities, there should be minimal effects on stormwater, gas, or electric service. The establishment of WWTPs would increase reliability of the wastewater service area on a regional basis as these systems would be centrally controlled and maintained by an independent utility. OWNRS are generally more difficult to monitor than WWTPs because they are decentralized, which may place an operational burden on responsible monitoring and enforcement agencies.

3.9.2.2.2 Alternative 2 – Centralized Wastewater Treatment Plant

There would likely be temporary adverse effects on utilities and services during the construction phase. The SER would evaluate effects on individual utilities, although no long-term impacts would occur if proper utility notification and construction practices are observed. The project applicant would be required to contact the diggers/excavation utility hotline at the Sunshine State One Call Center at least two business days prior to construction. Installation of WWTP piping could disturb existing drinking water piping, among other utilities. In this case, the pipes for either the WWTP or drinking water would be rerouted, depending on which is more feasible (Teague, Pers. Comm., 2001). This action would mitigate effects, though there may be temporary interruptions in water supply services.

Collection Option 1 – Vacuum Pumping

Aside from the impacts discussed above in Alternative 2, the selection of this collection option is not expected to result in long-term adverse effects on public utilities and services. Vacuum pumping systems do not require electric power at each residence; however, electric power at a central vacuum station is necessary. Vacuum valves have a shorter life than pumps, have a higher rate of energy consumption, have the potential to emit unpleasant odors at the vacuum facility, and require more frequent repair (Head et al., 2001). The project applicant would be required to develop backup power plans in the event that main power is lost to the vacuum pumping station.

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Collection Option 2 – Low-Pressure Grinder Pump Sewer System

Aside from the impacts discussed above in Alternative 2, the selection of this collection option is not expected to result in long-term adverse effects on public utilities and services. The low-pressure grinder pump sewer system requires less power than the vacuum system; however, power outages shut down the system. Periodic pumping of tanks at residences and businesses would be required, as would effluent pumps and grinder pumps needed at each residence (Head et al., 2001).

Disposal Options 1 and 2

It is not expected that impacts related to disposal options would occur beyond those discussed in Section 3.9.2.2.2.

3.9.2.2.3 Alternative 3 – On-Site Treatment Upgrades

Aside from the impacts discussed above in the No Action Alternative, the selection of this alternative is not expected to result in long-term adverse effects on Public Utilities and Services. An OWNRS demonstration project in Big Pine Key indicated that the systems provided BAT treatment levels as required by Florida Statutory Treatment Standards. As described in the No Action Alternative, the use of clustered OWNRS is more difficult to monitor because they are decentralized. To mitigate this effect, the project applicant proposing the clustered OWNRS would be required to establish a monitoring, compliance, and enforcement plan to help ensure that clustered OWNRS meet water quality and service reliability standards on a consistent basis.

3.10 LAND USE AND PLANNING

3.10.1 Affected Environment

About 90% of Monroe County is on mainland Florida. This portion of the county is located within either the Everglades National Park or Big Cypress National Preserve. While mainland Monroe County is almost uninhabited and consists almost entirely of federally owned and managed parklands, the majority of the county's development is located in the Keys (Monroe County, 1997).

Residential land uses, including single-family detached homes, mobile homes, multi-family apartments, and mixed-use residential areas are found on almost every one of the 38 Keys along US Highway 1. Residential uses account for 10,790 acres, or 17.6% of the total area of the Keys. Single-family detached homes are the predominant residential type in the Keys, and account for about 8,379, or 78% of the residential land use category. Mobile homes occupy the second largest residential land area, and include 1,063 acres. Multi-family residential development, including apartments, condominiums and cooperatives, account for 638 acres, or 6% of the developed residential land area. Mixed residential areas include about 711 acres, representing about 7% of the residential land use category (Monroe County, 1997).

Commercial land uses can broadly be defined as those uses associated with the buying and selling of goods and/or services. Commercial uses account for 2,270 acres, or 3.7% of the land area for the Keys portion of unincorporated Monroe County. Commercial land uses include general commercial, commercial fishing, and tourist commercial land uses. General commercial uses include retail and office uses oriented toward the resident population and represent the majority of commercial uses. Most of the commercial land uses are found along US 1 in the more populated areas of Key Largo, Marathon, and Upper Matecombe. Commercial fishing uses include land uses such as commercial marinas and landing areas, processing plants, boat repair and maintenance, and equipment and trap storage areas. Commercial fishing is heavily concentrated in the Lower Keys. Tourist commercial uses represent about 45% of the total commercial land use category, and are more heavily concentrated in the Upper and Middle Keys than the Lower Keys (Monroe County, 1997).

Conservation lands include lands that have been acquired by public agencies and private organizations for conservation purposes. This is the single largest land use category after vacant lands, and accounts for about 20,696 acres or 34% of the total land area of the Keys. These conservation lands are primarily located in the Upper and Lower Keys and indicate that the Federal and State governments have been actively acquiring environmentally sensitive lands and habitats of rare, threatened and endangered species. This category includes such conservation lands as Crocodile Lake National Wildlife Refuge, the National Key Deer Refuge, and the John Pennekamp Coral Reef State Park (Monroe County, 1997).

Vacant lands are the largest land classification in the Keys, and include an area of about 21,127 acres, or 34% of the total area of the unincorporated portion of the Keys. Vacant lands are heavily concentrated in the Lower Keys, as about 44% of the Lower Keys are classified as vacant (Monroe County, 1997).

Existing land uses are summarized in Table 3-13.

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Table 3-13: Existing Land Use Classification for Monroe County

Land Use Classification	Acreage (approx.)	Percentage of Total Land Area	Description
Vacant Land	21,127	34.0	Concentration in Lower Keys, about 44%
Conservation Land	20,696	34.0	Heavy concentration in Upper and Lower Keys
Residential	10,790	17.6	Single-family detached homes account for 78% of this category
Military Land	3,300	5.0	Located entirely in Lower Keys
Commercial	2,270	3.7	This category includes general commercial, commercial fishing, and tourist commercial
Recreation Land	1,791	3.0	Both public and private
Public Facilities	539	1.0	Land owned by public utilities and service providers
Industrial Land	515	<1.0	Concentration in Lower Keys; about 73%
Institutional Land	116	<1.0	Includes hospitals, churches, cemeteries and service clubs
Public Building/ Grounds	61	<1.0	Includes all government offices; local, State and Federal
Source: Monroe County Comprehensive Plan, Technical Document, 1997.			

Military lands account for about 5% of the total land area. The Keys have long been recognized as strategically significant by the U.S. military forces, and military operations still play an important role in the economy of the Keys (Monroe County, 1997). To a much lesser extent, land uses in the Keys include industrial, agricultural/ maricultural, institutional, educational, public buildings/grounds, public facilities, historic, recreation, conservation, and vacant lands (Monroe County, 1997).

According to the Monroe County Comprehensive Plan, Monroe County has about 37,128 lots zoned Improved Subdivision (IS), Urban Residential Mobile Home (URM), and Commercial Fishing Village (CFV).

3.10.1.1 Future Land Use and Planning

According to the Monroe County Comprehensive Plan, existing and future land use development in Monroe County is guided by three central principles: carrying capacity limitations, natural resource protection, and enhancement of community character. According to recent revisions of the Monroe County Comprehensive Plan, one goal of the county's comprehensive planning is to shift residential growth towards lower density single-family development and away from multi-family condominium and hotel/motel resort development, and toward the construction of new residential growth as infill development. Generally, this concept encourages development within established subdivisions and discourages growth within undeveloped subdivisions, acreage tracts, and areas that have sensitive natural resources or natural hazards (Monroe County, 1997).

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Due to Monroe County's development constraints, the Comprehensive Plan provides for a level of growth based on the county's carrying capacity, rather than matching growth to projected population based on estimated future demand. According to the Monroe County *Comprehensive Plan*, carrying capacity refers to the capability of a natural and built environment to accommodate additional population growth within the parameters of an acceptable environment (Monroe County, 1997).

In 1974, the State designated the Keys as an Area of Critical State Concern, a legal distinction authorizing extraordinary development controls and growth limits. However, unregulated growth continued until the Monroe County BOCC adopted the ROGO in 1992. ROGO was developed as a response to the inability of the road system to accommodate a large-scale hurricane evacuation in a timely manner. This ROGO system is used to distribute the number of permits for new dwelling units both geographically and over time, based on hurricane evacuation capacity of the road system. Each ROGO planning sub-area of unincorporated Monroe County and several incorporated areas receive a set number of allocations for new residential permits, which can be issued during that particular ROGO year. The total number of ROGO allocations that can be issued in a ROGO year is a maximum of 255 for unincorporated Monroe County, the Village of Islamorada, and City of Marathon, unless reduced by the Florida Administration Commission under its rule making authority. The number of allocations available to a particular area is based upon the supply of vacant developable, platted subdivision lots that could potentially be developed located in that area prior to the start of the ROGO system. The Director of Planning has 30 days to sort, evaluate, and rank applications by Upper, Middle, or Lower Keys sub-areas. Applications are placed in a sub-area according to their building locations (McGarry, Pers. Comm., 2002).

Under this permit allocation system, potential residential development proposals compete based on explicit performance criteria developed by the County. Criteria are assigned points (positive or negative) based on whether they support or detract from Monroe County's future land use concept and its three central development principles of carrying capacity, resource protection, and maintaining or enhancing community character (Monroe County, 1997). These categories that have scored criteria include habitat protection, affordable housing, coastal high hazards, water conservation, and energy conservation among others. Through the point system, development located and designed to provide the greatest public benefit have the strongest chance of receiving a ROGO allocation award that authorizes the issuance of a building permit. Wastewater management improvements are not included among the scored criteria.

In conjunction with the ROGO permitting system, Monroe County also implements a nutrient reduction credit program required by Policy 101.2.13 of the Monroe County Year 2010 Comprehensive Plan. The nutrient reduction credit program requires that each ROGO allocation award must be matched with a nutrient reduction credit. Nutrient reduction credits are generated through the elimination of cesspools/substandard wastewater treatment systems and their upgrading to an approved wastewater treatment system. Building permit applicants are eligible to receive or purchase nutrient reduction credits once their approved building permit application has been entered in the ROGO system (Stankiewicz, Pers. Comm., 2001). The Monroe County Health Department administers the nutrient reduction program and is responsible for the tracking of these credits through a unique number of identifying systems. A nutrient reduction credit is issued when a cesspit or non-compliant wastewater treatment system is replaced with a wastewater treatment system compliant with Florida Statutory Treatment Standards in

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accordance with Table 3.1-1 of Policy 101.2.13 in the Monroe County Year 2010 Comprehensive Plan. A ROGO allocation award will not be made until a nutrient reduction credit is available in that same ROGO planning sub-area (e.g., Upper, Middle, or Lower Keys). As non-compliant systems are replaced and the new systems receive final inspections, nutrient reduction credits become available. Except for nutrient reduction credits that are purchased, credits are issued in the order that the ROGO applications were ranked. Nutrient reduction credits are divided between market rate residential units and affordable housing residential units in an 80:20 proportion. Thus, the first four market rate applications receive nutrient reduction credits and then the first affordable housing application and so forth.

A ROGO applicant has the option of purchasing his/her nutrient reduction credit rather than waiting for it to become available independently. The nutrient reduction credit will be reserved with the Monroe County Health Department until the quarter in which the ROGO applicant receives a ROGO allocation ranking sufficiently high enough to otherwise receive a building permit. An applicant must be in the ROGO system before a nutrient reduction credit can be reserved.

Development is also constrained to maintain a balance of land uses. The Comprehensive Plan's Policy 101.3.1 states:

“Monroe County shall maintain a balance between residential and non-residential growth by limiting gross square footage of non-residential development over the 15 year planning horizon in order to maintain a ratio of about 239 square feet of non-residential development for each new residential unit permitted through the Permit Allocation System...”

There has been a de facto moratorium on non-residential growth since January 4, 1996 because the amount of non-residential floor area exceeded the 239-foot ratio established by the Monroe County Comprehensive Plan. Residential development has continued and by December 2000 had equaled the non-residential permits. A draft “Non-residential Rate of Growth Ordinance” adopted by Monroe County on July 18, 2001 proposes to maintain a ratio of about 239 square feet of non-residential floor area for each new residential permit issued through ROGO.

The Monroe County Planning and Environmental Resources Department is required to prepare an annual assessment of public facilities capacity mandated by Section 9.5-292 of the Monroe County Land Development Regulations. Furthermore, the State of Florida requires all local jurisdictions to adopt regulations to ensure the public facilities and services which are needed to support development are available concurrent with the impacts of development in addition to maintaining the adopted Level of Service (Chapter 9J-5 of the F.A.C.).

According to the Monroe County Comprehensive Plan, population growth over the next 10 years in Monroe County (unincorporated and incorporated) will correspond to the number of building permits that will be issued for new residential units. This is because development is based on maintaining hurricane evacuation clearance times at or below 24 hours as required by the Monroe County Comprehensive Plan (McGarry, Pers. Comm., 2002). The use of the ROGO permit allocation system as the guiding policy that limits population growth in the Keys suggests that population growth is not directly based on accommodating market demand for development, matching development to available or planned public facilities and services, responding to

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competing factors outside of the community such as growth in adjoining Miami-Dade County, or unilaterally maintaining past rates of growth.

Separate from the Monroe County's Comprehensive Plan, the Village of Islamorada has its own Comprehensive Plan which became effective on December 6, 2001. As part of the plan, the Village adopted a Building Permit Allocation System (BPAS), which is similar to and replaces ROGO within Islamorada. The BPAS regulates both residential and non-residential growth through the year 2020 and the residential allocations include the same nutrient reduction requirements as Monroe County. During the period from 2001-2020 the BPAS allows a total of 302 residential unit, an average of 15 per year. These allocations are comprised of 171 market rate and 131 affordable. Non-residential floor area is limited to 28,680 square feet over the same period or an average of approximately 1400 square feet per year (Tindle, 2002).

3.10.1.2 Land Use, Planning, and Wastewater Management

Wastewater flow and customer projections were developed from the FKAA water use records for each of the 27 study areas outlined in the MCSWMP for the baseline year 1998 and for the 10-year and 20-year planning horizons, 2008 and 2018, respectively. This included residential (i.e., residential single unit, senior citizens, and residential multi-units) and non-residential components (i.e., remaining sources such as restaurants, laundry facilities, etc.). Total residential flow is estimated to increase from 31,847 EDUs (4.5986 Mgal) to 34,613 EDUs (5.0183 Mgal) between 1998 and 2008, or an approximately 8.7% increase. Total non-residential wastewater flow is estimated to increase from 17,004 EDUs (2.5475 Mgal) to 17,594 EDUs (2.6341 Mgal) between the same period, or an approximately 3.5% increase. For the 20-year planning horizon, total residential and non-residential flows are estimated to increase approximately 17% and 7% between 1998 and 2018, respectively. Increases in residential EDUs for the 10- and 20-year planning periods were determined from historical ROGO allocations, estimated future ROGO allocations, and the number of future units in each study area that have development potential and were vested or exempt from ROGO. Future residential flow projects for the study areas were calculated by multiplying the increase in EDUs by the average flow per EDU within each study area. Increases in non-residential flow within the study areas were estimated by assuming the commercial development would resume in 1999 under "Commercial ROGO" allocations described in Monroe County Year 2010 Comprehensive Plan and that this commercial growth would be within the 239 square foot ratio distributed in proportion to residential growth.

The Keys have very little industrial and agricultural activity; however, permits are required for non-residential development such as industrial, commercial, non-profit, and public buildings. The predominant form of non-residential development is commercial. Commercial entities cannot be placed on vacant land unless it is permitted (referred to as commercial moratorium), however wastewater treatment facilities can be located in any land use district other than residential land use districts (Garrett, Pers. Comm., 2001). In addition, once a plant is placed in a certain land use district, zoning does not change. The Monroe County BOCC is considering allowing wastewater treatment facilities to be placed in residential land use districts. The BOCC is currently reviewing changes to the land development regulation in the Monroe County Code, and it is certain if and when they will make their decision (Reisinger, Pers. Comm., 2001).

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3.10.1.3 Conservation and Recreation Lands

The Conservation and Recreation Lands (CARL) acquisition program, or Forever Florida program, seeks to protect and conserve environmentally, archaeologically, historically, or naturally significant lands in Florida. Properties acquired by CARL are purchased by the State under FDEP, and management of the land is performed by other State agencies having an interest in the operation of the land. The program emphasizes the acquisition of lands from willing landowners that contribute to the program voluntarily. Although anyone may propose a certain project for acquisition, The Acquisition and Restoration Council perform the ultimate selection and ranking of projects by significance each year. The entire acquisition program is supervised by the Governor and Cabinet, and they retain the authority to approve the recommended acquisition list, approve specific purchases, and declare eminent domain for the purposes of preserving lands that are significantly rare, sensitive, or threatened. Within Monroe County, about 34% of the land area is designated with a land use classification termed Conservation Land, which includes CARL lands. These areas are concentrated in the Upper and Lower Keys and comprise about 20,696 acres in Monroe County.

3.10.1.4 Coastal Zone

The Coastal Zone Management Act (CZMA) was passed by Congress to encourage coastal states to develop programs that would comprehensively manage activities having coastal impacts. States with an approved coastal zone management program have the authority to review Federal actions for program consistency. Florida's DCA, which serves as the lead coastal agency, implements the regulations of the CZMA.

In Monroe County, coastal zone protection is provided under the Monroe County Code of Ordinances (Ordinance Number 2-1980) and incorporated into the Monroe County Comprehensive Plan.

3.10.1.5 Barrier Island Resources

Areas of Monroe County are designated as Coastal Barrier Resource System (CBRS) units or undeveloped coastal barriers along the Keys. These coastal barriers provide protection for diverse aquatic habitats and serve as a defense against the impacts of severe coastal storms and erosion. The Coastal Barrier Resources Act (CBRA) of 1982 prohibits Federal funding for any project that could result in an increase in development in the CBRS units. Monroe County policies regarding protection of the CBRS units are included under Objective 102.8 of the Year 2010 Comprehensive Plan Policy Document. This objective specifies that Monroe County would discourage the extension of facilities and services such as electricity and telephone service to CBRS units. Additionally, the objective discourages developments, and construction of access via bridges, causeways, paved roads, or commercial marinas to or on CBRS units. In early 2002, Monroe County adopted an Overlay Zoning District for 14 of the CBRS units, which implements the policies and objectives of the Comprehensive Plan. A map of CBRS units is included as Figure 3-9.

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FIGURE 3-9 CBRS MAP

3.10.2 Environmental Consequences

3.10.2.1 Alternative 1 – No Action Alternative

Given the similarity of impacts across all land uses, the following discussions pertain to all land uses designated above. Effects on a particular land use are specified where appropriate.

- The construction of new WWTPs and/or installation OWNRS is not expected to result in major changes to existing land uses. New wastewater treatment systems would likely be located on vacant land, and occupy between 1 and 5 acres depending on the size of the system. According to the Monroe County Planning Department (Tummini, Pers. Comm., 2001), wastewater treatment systems may be placed on land zoned in the following categories:
 - Urban Residential
 - Urban Residential Mobile
 - Suburban Community District
 - Urban Residential Mobile Home Limited
 - Suburban Residential District
 - Sparsely Settled Urban Residential District
 - Native Area District
 - Improved Subdivision
 - Improved Subdivision Vacation Rental District
 - Mixed Use District
 - Industrial District
 - Airport District
 - Suburban Commercial

The installation of new WWTPs, upgrading of WWTPs, and conversion of OWTS to OWNRS is not expected to cause changes in growth. The capacity of wastewater treatment alternatives proposed in the MCSWMP are based on accommodating a 17% increase in residential wastewater use and 7% increase in non-residential use over a 20-year planning period (1998 to 2018). As is typical for capital-intensive projects that have project lives in excess of 10 years, the capacity of proposed wastewater management projects take into account future demand for wastewater disposal. As described in Section 3.10 above, these growth projections are based on the present ROGO permitting system that limits growth in Monroe County. This analysis assumes the ROGO system will continue as it has historically. The project-specific SER would consider change to ROGO should they occur.

Under the No Action Alternative, wastewater management improvements would be done at a slower rate without FEMA funding. As described in Section 3.10.1.1, the release of ROGO permits is based on the availability of nutrient reduction credits. Credits become available when inadequate on-site wastewater systems are replaced with systems that meet Florida Statutory

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Treatment Standards. Accordingly, if wastewater management improvements occur at a slower rate, the availability of nutrient reduction credits is also slowed; therefore, growth rates and patterns may be altered from those initially set forth by the Monroe County planning department. It should be noted that regardless of the availability of nutrient reduction credits, the number of new buildings allowed in unincorporated Monroe County is set forth by the ROGO system that is established by the Monroe County BOCC.

The impact of wastewater management projects on CARL lands and conservation lands, areas managed under the CZMA, and CBRS units in the Keys would depend on the siting of individual projects in relation to these lands. Although projects that do not receive Federal funding are not obligated to comply with CZMA or CBRA, they may result in cumulative effects on these special status lands in relation to other Federal actions considered in the PEA. Local land development regulations promulgated by the Monroe County Comprehensive Plan also set forth requirements related to CARL, CBRS, and conservation lands that would be adhered to.

In terms of the positive impacts on ground and nearshore waters identified in Section 3.2 of this PEA, the proposed WWTP should result in generally positive effects on the natural resource value of CARL and conservation lands, CBRS units, and coastal areas that derive their natural resource value from good water quality; although these benefits would likely occur later in time with FEMA funding assistance.

3.10.2.2 *Alternative 2 – Centralized Wastewater Treatment Plant Alternative*

The construction or upgrading of new WWTPs is not expected to result in major changes to existing land uses. New wastewater treatment systems would likely be located on vacant land, and occupy between 1 and 5 acres depending on the size of the system. According to the Monroe County Planning Department (Tummini, Pers. Comm., 2001), wastewater treatment systems may be placed on land zoned in the categories referenced above in Section 3.10.2.1. Depending on the specific siting location, the construction of a new WWTP may have the effect of establishing a precedent for more industrial or non-residential land uses in the project area. Because the effect on land use is both project and site specific, these impacts would be further developed in the SER prepared for the individual project.

The installation or upgrading of new WWTPs is not expected to cause changes in growth. The capacity of wastewater treatment alternatives proposed in the MCSWMP, the plan from which FEMA-funded projects would be selected, are based on accommodating a 17% increase in residential wastewater use and a 7% increase in non-residential use between 1998 and 2018. As is typical for capital-intensive projects that have project lives in excess of 10 years, the capacity of proposed wastewater management projects take into account future demand for wastewater disposal. These growth projections are based on the present ROGO permitting system that limits growth in Monroe County.

Because of the Federal funding assistance, implementation of this alternative would likely result in a quicker availability of nutrient reduction credits in the service area. This could result in an apparent short-term, increase in growth in the area where the credits are made available. However, the growth rate would be constrained by ROGO, as described in Section 3.10.1.1. The site-specific SER would contain a more detailed discussion of nutrient reduction credits, as appropriate.

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The impact of wastewater management projects on CARL lands and conservation lands in the Keys would depend on the siting of individual projects in relation to these lands. Because these impacts are both project and site specific, the individual SER prepared for a subject project would evaluate effects on CARL lands.

As part of the SER, FEMA would determine whether proposed project is located within the jurisdictional area of the CZMA. If this is the case, the Florida DCA would be required to review the plans of the WWTP for consistency with its comprehensive coastal management program. As described in Section 3.10.1.5, CBRA prohibits Federal funding for any project that could result in an increase in development in the CBRS units. Accordingly, no FEMA funding would be granted to project alternatives that site a WWTP in or serve CBRS units. In terms of the positive effects on ground and nearshore waters identified in Section 3.2 of this PEA, the proposed WWTP should result in generally positive effects on the natural resource value of CARL and conservation lands, CBRS units, and coastal areas that derive their natural resource value from good water quality.

Collection Option 1 – Vacuum Pumping

The selection of vacuum pumping alternative would require the siting of one or more vacuum pumping stations. Land use and planning effects associated with this alternative would be similar to those described in Section 3.10.2.2.

Collection Option 2 – Centrifugal Grinder Pump System

Since this system operates underground, there would be no notable effects to land use and zoning other than those described for the WWTP itself in Section 3.10.2.2.

Disposal Options 1 and 2

Both disposal options would have impacts similar to those described in Section 3.10.2.2.

3.10.2.3 Alternative 3 – On-Site Treatment Upgrades

On-site treatment system upgrades to clustered OWNRS that remain in the same geographic location are expected to have a minimal effect on land use and planning. Clustered OWNRS that would be sited at new locations are expected to result in minimal effects on existing land use because they would be presumably sited on vacant lands. According to the Monroe County Planning Department (Tummini, Pers. Comm., 2001), wastewater treatment systems may be placed on land zoned in the categories referenced in Section 3.10.2.1. Because the effect on land use is both project and site specific, these impacts would be further developed in the SER.

The conversion of OWTS to OWNRS is not expected to cause changes in growth. OWNRS are generally constructed for existing development or in light of short (1 to 5 year) planning horizon. This is because they serve limited numbers of households (1 to 50 households possible), (Monroe County, 2000a). As with Alternative 2, implementation of this alternative would likely result in a quicker availability of nutrient reduction credits in the service area. This could result in an apparent short-term, increase in growth in the area where the credits are made available. However, the growth rate would be constrained by ROGO, as described in Section 3.10.1.1. The site-specific SER would contain a more detailed discussion of nutrient reduction credits, as appropriate.

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The impact of OWNRS on CARL lands and conservation lands in the Keys would depend on the siting of individual projects in relation to these lands. Because these impacts are both project and site specific, the individual SER prepared for a subject project would evaluate effects on CARL lands. Effects on CZMA, CBRA, and CARL would be similar to those described in Section 3.10.2.2.

3.11 NOISE AND VISUAL RESOURCES

3.11.1 Noise

3.11.1.1 Affected Environment

Noise, or unwanted sound, was originally managed at the Federal level by the Noise Control Act of 1972, which was administered by the EPA. Under this Act, Congress tasked the EPA with determining the extent and effects of different qualities and quantities of noise and to define acceptable levels of noise towards public health and safety (NPC, 2001). Since 1982, the responsibility of noise abatement and control has been delegated to the State and local governments, but the noise levels and exposure recommendations developed by EPA under the Noise Control Act are still relevant. The EPA describes sound in terms of its amplitude (loudness), frequency (pitch), and time pattern (continuous, fluctuating, intermittent, impulsiveness). A decibel (dBA) is a unit of sound amplitude, whereas a hertz (Hz) is a unit of sound frequency. For the purpose of discussing noise levels in this PEA, sound will be measured and discussed in units of decibels.

The State of Florida achieves noise control through a State noise statute (Title XXIX, Public Health, Chapter 403) that outlines general and specific prohibitions relative to noise levels. Additionally, Article III, Sections 13-51 to 13-55 of Monroe County Code has the Monroe County noise ordinance regulations. Noise effects are discussed in terms of public hazards, where the focus is on the effects to community citizens and adjacent land uses, and in terms of occupational hazards, which focuses on effects on laborers (as mandated in 29 CFR 1910.5, Occupational Noise Exposure, administered by the Occupational Safety and Health Administration [OSHA]). Under the proposed alternatives, it is likely that both public and occupational noise impacts would occur.

Sensitive noise receptors in the Keys could include schools, residential areas, hospitals, churches, and public facilities, such as parks and recreational areas. Sensitive receptors are considered areas that sustain greater impacts from noise sources than other areas (such as industrial areas). An evaluation of sensitive receptors in the specific project areas would be conducted as part of the SER.

Ambient noise levels (background sound) at the proposed project sites would vary depending on noise sources present in the areas. For the purpose of discussing impacts, existing noise levels at the sites are represented by land uses and their corresponding average noise levels, since specific sites are yet unknown. Table 3-14 presents estimated outside noise levels associated with certain land uses and locations measured in dBAs (Day-Night Sound Level [Ldn]). The presented noise levels serve as baseline noises, from which impacts will be discussed. As point of reference, a consistent level of 70 dBAs is identified for all areas in order to prevent hearing loss (EPA, 1974).

Table 3-14: Approximate Noise Levels in Decibels Based on Land Uses (representing project sites)

Land Use	Decibel	Similar Sound (Point of Reference)	Overall Noise Level
Wilderness Area	35	Library (37-42 dBA)	Quiet
Rural Residential Area	39	Library (37-42 dBA)	Quiet
Agricultural Crop Land	44	Bird calls (38-52 dBA)	Quiet
Wooded Residential Area	51	Rainfall (31-55 dB)	Quiet
Old Urban Residential Area	59	Sewing Machine (57-63 dBA)	Quiet to Moderately Loud
Urban Housing on Major Avenue	68	Vacuum cleaner (65-82 dBA)	Moderately Loud
Freeway Traffic	70	Vacuum cleaner (65-82 dBA)	Moderately Loud
Downtown Area with Some Construction Activity	79	Ringling Telephone (78-82 dBA)	Moderately Loud
Heavy Traffic	85	Handsaw (83-87 dBA)	Moderately Loud
Sources: Noise Center of the League, 2001; NCP, 2001; and Branch et al., 1970.			

As a final distinction between noise levels and land use, it is preferable that areas associated with hospitals and schools measure less than 45 dBAs, and areas that allow outdoor human activities (such as a park) should measure less than 55 dBAs. These noise thresholds allow spoken conversation, sleeping, work, and recreation activities without interference or annoyance (EPA, 1974).

3.11.1.2 Environmental Consequences

For the purposes evaluating consequences, noise impacts are considered in terms of a baseline ambient noise for a given area (represented in this document by land uses) combined with noises generated by the alternatives. When adding noise levels (when several different noises occur at the same time), the decibels associated with a noise are combined on a logarithmic scale (decibels cannot be added or subtracted in the usual arithmetical way). The table below illustrates a simplified manner in which to combine noise levels. As an example, if one machine emits a noise of 90 dBA, and a second identical machine is placed beside the first, the combined sound level is 93 dBA, not 180 dBA. Adding a noise that is less than the ambient noise results in no numerical change because the additional noise would be imperceptible. Adding noise that is 10 dBAs or higher than the ambient noise would result in a new noise level of the louder noise. For example if your workplace noise is 80 dBA and you add a machine measuring 95 dBA, the overall noise level would equal 95 dBA (CCOHS, 2001).

Table 3-15: Addition of Decibels

Numerical Difference Between the Two Noise Levels (dBA)	Amount to be Added to the Highest of the Two Noise Levels (dB or dBA)
0	3.0
0.1 – 0.9	2.5
1.0 – 2.4	2.0
2.4 – 4.0	1.5
4.1 – 6.0	1.0
6.1 – 10	0.5
10	0.0
Source: CCOHS, 2001	

3.11.1.2.1 No Action Alternative, Centralized WWTP Alternative, and OWNRS Alternative

Given that the activities under each of these alternatives would involve a range of construction activities, the impacts related to construction and noise at the project sites would be similar for all alternatives; therefore, this discussion pertains to all alternatives. Following this discussion, an analysis of noise and WWTP operations is presented, but pertains only to the Centralized WWTP alternative. It should be noted that business and residential citizens located adjacent to project sites and laborers working at the sites will incur different levels of impact due primarily to distance and noise reduction of buildings. For these reasons, effects on citizens and laborers are discussed separately.

Effects on Citizens

All construction activities under all alternatives would have some noise impacts. Noise levels at all project sites are expected to rise above typical day-night averages, which in this document are represented by land uses since the specific sites are yet undetermined (refer to Table 3-13: Approximate Noise Levels in Decibels Based on Land Uses). Land use noises are defined by noise levels that are generally “quiet” or “moderately quiet.” Construction noises would typically occur at decibels over those associated with project site noise levels. Therefore, noise level increases could be substantial when compared with existing ambient noise levels. However, even though the change in sound energy associated with construction noise is substantial, the overall decibel level may not be significant in terms of adverse health effects.

While the overall decibel increase at project sites would likely be substantial over present ambient levels, the distance between residents and business owners and the construction activity, as well as noise reduction offered by buildings (where these populations would likely be most of the time) would dilute the level of sound actually reaching most citizens adjacent to the construction sites. The contribution of outdoor noise to indoor noise is usually small, 0.5 to 1.5 dB (NPC, 2001). The intensity of a source, the distance of that sound, and the sound level reduction afforded by a building influence the amount of sound that ultimately enters a building and disturbs citizens located inside. Buildings constructed in cold climates offer

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greater sound reduction than those constructed in warm climates, although the difference is minimal, 0.5 to 1.0 dB. Given the warm climate of the Keys, it is assumed that a building can reduce outside sounds by 12 dBA s when windows are opened, and by 24 dBAs when windows are closed (NPC, 2001). This reduction represents a substantial change in overall noise levels entering a residence, business, or school.

Additional reductions can be assumed when factoring in distance and buffering materials located between the citizen and the construction activity. According to Marsh (1991), the magnitude of sound from a source decreases at a rate of 3 to 6 dBA with each doubling of travel distance. Further, vegetation in the path of sound can absorb and divert some sound. Vegetative buffers are most effective when a topographic barrier (berm or embankment) is used alongside plantings.

Overall, effects on citizen groups would vary from site to site, depending on the type of construction activity, the distance between the site and population affected, and whether windows are opened or closed. An increase in localized noise levels is expected during construction at various locations over the course of about 18 months (Teague, Pers. Comm., 2001), and area populations may endure annoying and disruptive noises during allowable construction work hours, as cited in the applicable noise ordinance. The potential for a population to experience hearing damage or loss due to construction noises is considered low, however the SER would evaluate site-specific characteristics to adequately evaluate risks. To mitigate noise impacts, the applicant would implement measures such as use of vegetative barriers and would obey the established noise ordinance, Article III, Sections 13-51 to 13-55 of Monroe County Code in order to reduce annoying and disruptive noises to adjacent areas. Citizens can mitigate indoor noise by keeping windows closed for the duration of construction. Impacts related to noise would be further evaluated in the SER that would also include project-specific mitigation measures.

Impacts on Workers

All alternatives would have some noise levels that may adversely affect workers at the construction sites and in the WWTP facilities. Construction noise levels can damage human hearing abilities depending on the sound and exposure levels (Table 3-16). It is expected workers would not have the noise reduction benefits of distance, vegetative buffers, or buildings. Once construction of WWTPs is complete, noises associated with typical WWTP operations may adversely affect the workers (Table 3-17).

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Table 3-16: Noise Levels Associated with Common Construction Activities

Construction Activity	Associated Decibels	Risk from Exposure (representative of range of decibels)	Permissible Exposure Limits (minute/hour at maximum level; no protective equipment worn)
Rock Drilling	Up to 115	Chance of Hearing loss to Harmful to Hearing	15 minutes
Heavy Equipment Operation	95 – 110	Chance of Hearing loss to Harmful to Hearing	30 minutes
Jack Hammer	102 – 111	Chance of Hearing loss to Harmful to Hearing	26 minutes
Concrete Joint Cutter	99 – 102	Chance of Hearing Loss	1 hour, 30 minutes
Skilsaw	88 – 102	Chance of Hearing Loss	1 hour, 30 minutes
Bulldozer	93 – 96	Chance of Hearing Loss	3 hours, 30 minutes
Earth Tamper	90 – 96	Chance of Hearing Loss	3 hours, 30 minutes
Crane	90 – 96	Chance of Hearing Loss	3 hours, 30 minutes
Backhoe	84 - 93	Chance of Hearing Loss	5 hours, 18 minutes
Gradeall	87 - 94	Chance of Hearing Loss	About 4 hours
Source: Marsh, 1991.			

Table 3-17: Noise Levels Associated with Wastewater Treatment Plant Operations

WWTP Operating Area	Estimated Noise Level (dBA)
Generator Room	77-91
Pump Room	77-100
Vacuum Pump Trucks	74-92
Sludge Thickening Rooms	63-98
Source: State of New Jersey, 2001	

To mitigate noise impacts, workers would comply with applicable occupational safety regulations and implement appropriate noise control measures, such as wearing hearing protection (e.g., ear plugs, ear muffs, a helmet, or canal caps) and limiting exposure times, as appropriate. If these measures are implemented during construction and operations, no adverse effects on workers should occur. Impacts related to noise would be further evaluated in the SER that would also include project-specific mitigation measures.

3.11.2 Visual Resources**3.11.2.1 Affected Environment**

Visual resources refer to the landscape character (i.e., what is seen), visual sensitivity (i.e., human preferences and values regarding what is seen), scenic integrity (i.e., degree of intactness and wholeness of landscape character), and landscape visibility (i.e., relative distances of seen areas) of a geographically defined viewshed. The Keys' viewshed is presented below in general terms, and the viewsheds of each project site would be described in the specific SER.

Keys' visual resources vary greatly depending on the location. The Keys has dense urban development dominated by roadways, boating canals, boat marinas, and residential, industrial, and commercial structures. In general, even the urban areas support many vegetation types, providing a lush setting for the communities. The Keys support many natural areas, which provide vistas of coastal communities consisting of mangrove forests and salt marshes; upland communities consisting of tropical hardwood hammocks and pine rockland communities, both on slightly higher elevations; and marine habitats including beaches and nearshore waters.

In order to assess the viewshed of a given project area, a visual resource assessment may be conducted that integrates the benefits, values, desires, and preferences regarding aesthetics and scenery for all levels of land management planning. A visual resource assessment would assess and evaluate landscape character, scenic integrity, constituent information, landscape visibility, and scenic class of the viewshed relative to each project site. The purpose of this assessment is to create a numeric value score for each project site relative to each of the parameters based on accepted methodology, and to use the numeric score to interpret the degree of visual impacts.

3.11.2.2 Environmental Consequences

Depending on the existing visual quality of a proposed site, FEMA would assess impacts related to visual resources in the project-specific SER. This assessment would examine viewshed effects in terms of the scenic quality, unique natural communities, high quality and unique views, and the proximity of project activities to developed and natural areas.

Cumulative impacts, in the NEPA context, are the environmental impacts that result from the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal), business, or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

In order to adequately address the cumulative impacts of a given wastewater management improvement project, it is necessary to examine project-specific details. As such, the cumulative impact discussion of the projects proposed for FEMA funding assistance would be focused at the project-specific SER level. However, due to the wide array of projects concerned with water quality currently planned or underway in the Keys and South Florida, the below discussion focuses on the cumulative impacts of these regional projects as related to the proposed FEMA-funded projects.

4.1 CONCURRENT PROJECTS

4.1.1 Comprehensive Wastewater Management Activities

As a result of declining nearshore water quality in the Keys, a number of Federal, State, and local laws and regulations have been implemented to improve wastewater and stormwater management, monitor water quality, assist in financing water quality improvements, and establish new water quality monitoring standards. In particular, the *Monroe County Year 2010 Comprehensive Plan*, as well as, Florida EO 98-309 and F.A.C. 99-395, mandate that nutrient loading levels be reduced in the marine ecosystem of the Keys by the year 2010. Specific actions include eliminating cesspits, failing septic systems and other substandard on-site sewage systems, and requiring that all wastewater discharge be treated to Florida Statutory Treatment Standards. In response to the mandated wastewater treatment improvements, Monroe County prepared the MCSWMP, which has recommendations for a number of wastewater management projects that would improve water quality throughout the Keys. In total, the MCSWMP recommends 12 community WWTPs and 5 regional WWTPs. Five of the 12 community WWTPs feature interim WWTPs that, over time, will be phased into larger regional systems.

4.1.2 Comprehensive Stormwater Management Activities

In addition to developing a comprehensive wastewater management plan, Monroe County has prepared a comprehensive stormwater management plan to address the detrimental effect to water quality of stormwater flow emanating from developed areas. Recent estimates attribute about 20% of the nearshore nitrogen loading and about 45% of the phosphorous loading emanating from the Keys to stormwater (EPA, 1993a; Kruczynski, 1999). Released in August 2001, the SMMP recommends 24 site-specific stormwater management projects (e.g., vegetated berms and porous pavement), to reduce sediment loading.

4.1.3 Everglades Restoration

The Everglades ecosystem extends from the Chain of Lakes south of Orlando to the reefs surrounding Fort Jefferson southwest of the Keys. The natural system has been severely degraded by flood control and water distribution systems, growth and development, and

agriculture. High levels of phosphorus, mercury, and other contaminants have occurred in the water system from urban stormwater and agricultural runoff (FDEP, 2002). In an effort to restore the Everglades ecosystem, the Comprehensive Everglades Restoration Plan (CERP) was developed with USACE and SFWMD as the lead agencies. The CERP includes a broad range of projects including the examination of aquifer storage and recovery; in-ground reservoir technology; levee seepage management technology adjacent to Everglades National Park; and advanced wastewater treatment technology to determine the feasibility of using reuse water for ecological restoration. Additionally, components of the CERP include the Arthur R. Marshall Loxahatchee National Wildlife Refuge internal canal structures, the Lake Okeechobee watershed water quality treatment facilities, and the Keys Tidal Restoration Project. There have been concerns that the large-scale environmental restoration projects in the Everglades will increase the freshwater flow to Florida Bay and, subsequently, increase nutrient loading.

4.2 CUMULATIVE IMPACTS

4.2.1 Topography, Soils, and Geology

The cumulative effects on topography and soils as result of the concurrent, region-wide projects are expected to be minimal. The implementation of new wastewater treatment alternatives throughout the Keys would result in the cumulative increase in the impervious surface area due to the construction of WWTPs and clustered OWNRS systems; however, the actual land area required for these activities is limited relative to the extent of the Keys surface area. Given the flat topography of the Keys, wastewater projects are not expected to change surface topography. As described in Section 3.1.1.3, the reduction of nutrients inputs as a result of wastewater and stormwater management projects would likely benefit coral reefs; thereby, reducing the potential for wave erosion during storms. Soils would be temporarily disturbed during stormwater and wastewater management projects; however, the implementation of the comprehensive SMMP would decrease the potential for long-term surface soil erosion. With respect to geology, the potential cumulative effects of wastewater management projects are expected to be minimal as described in Section 3.1.3.2.2. This section discusses sinkhole development, limestone solution, and pressure buildup as they relate to the hydrogeology of the Keys.

4.2.2 Water Resources and Water Quality

In light of concurrent wastewater and stormwater management activities and the CERP, improvements to the water quality of canal, nearshore, and offshore waters are expected. Water quality sampling, such as that being conducted through the WQPP as described in Section 3.2.3.1.2 would assist in quantifying the extent of these improvements. As further detailed in Section 3.2.2.2.1 and Appendix D, the conversions of cesspits and septic tanks to systems that meet Florida Statutory Treatment Standards are expected to result in about 92% reduction in TN input to groundwater and 86% reduction in TP input to groundwater attributed to wastewater sources in the Keys. Reduced groundwater nutrient loading would also reduce nearshore nutrient loading because of groundwater movement. Wastewater has been estimated to account for 80% of the TN and 55 to 56% of the TP loading to nearshore waters. Similarly, it is estimated untreated stormwater runoff accounts for 20% of the TN and 44 to 45% of the TP loads to nearshore waters (EPA, 1996; Kruczynski, 1999). Accordingly, successfully implementing both

the MCSWMP and MCSMMP should substantially reduce nutrient loading from the Keys, resulting in a cumulative benefit to at least nearshore water quality.

Additionally, there have been concerns that the large-scale Everglades restoration projects will increase freshwater flow to Florida Bay and, subsequently, increase nutrient loading. In an analysis of how changing freshwater inflow to the southern Everglades is likely to change the input of nutrients to Florida Bay, Rudnick et al. (1999) found that TP inputs from the Everglades are not likely to increase; however, an increase in TN may be expected. Despite these results, the study found that nitrogen and phosphorus inputs from the Gulf of Mexico greatly exceeded inputs from the Everglades. The freshwater Everglades were identified as contributing less than 3% of all phosphorus inputs and less than 12% of all nitrogen inputs to Florida Bay. These nutrients were primarily attributed to runoff from agricultural and residential areas, natural nutrient levels, and atmospheric deposition (Rudnick, et al., 1999).

4.2.3 Biological Resources

The overall cumulative effects to biological resources as a result of the concurrent projects identified in Section 4.1 are expected to be beneficial. As described in Section 3.3.2.1, positive effects to nearshore marine habitats including seagrass meadows and coral reefs would likely occur due to the reduction of TSS, nutrients, and pathogens released to the nearshore waters that would be expected as a result of wastewater improvement activities; as well as stormwater improvements and the CERP. Corals typically thrive in an oligotrophic (nutrient-poor) environment with the assistance of specialized symbiotic algae (i.e., zooxanthellae); these algae derive their nutrients from the waste products of their coral hosts and, as such, are not typically limited by the availability of free nutrients from the water column (Hallock et al., 1993). Other benefits of decreased TSS and nutrient release may include increased growth of seagrasses due to increased light penetration. Algal blooms may also become less frequent, pervasive and damaging as a result of the reduced TP and TN concentrations.

The project activities associated with the wastewater and stormwater programs in the Keys have the potential to result in the loss of habitat; however, most activities would occur in developed, disturbed areas with low habitat value. Appropriate site selection and mitigation measures would minimize the cumulative impacts of these programs. Any potential loss in terrestrial habitat would need to be considered in terms of the improved water quality that would result from wastewater and stormwater management activities and subsequent benefits to aquatic habitats, such as seagrasses and coral reefs communities.

Cumulative effects to special status species would be similar to those described for biological resources, in general. Site selection, the implementation of appropriate mitigation measures, and coordination with responsible agencies such as USFWS and NMFS would minimize potential, cumulative adverse impacts.

4.2.4 Air Quality

Potential cumulative effects on air quality as they relate to the projects described in Section 4.1 are expected to be minimal.

4.2.5 Cultural Resources

The wastewater and stormwater programs, as well as the CERP, may result in ground disturbing activities that may impact historical and archaeological resources if present. However, these impacts are expected to be minimal because most work would be done at previously disturbed sites. The implementation of mitigation measures, appropriate site selection, and coordination with the FSHPO would minimize these potential cumulative impacts.

4.2.6 Socioeconomics

The implementation of the wastewater and stormwater programs would cumulatively improve ground and nearshore water quality and presumably reduce or eliminate the number of health advisories in beaches and canals in the Keys. This would likely increase the number of visitors to beaches that formerly posted advisories, and/or reduce visitor pressure on alternate beaches and recreational activities. These water quality improvements would also benefit commercial fisheries to the extent they are currently being adversely impacted by nutrient pollution. Generally, it may be predicted that harvested species that occur in nearshore waters such as spiny lobster, white mullet, gray snapper, various flounder, shrimp, and stonecrab would benefit from improved water quality. In consideration of the cumulative effect of on-going stormwater management activities, wastewater management activities in the Keys, and the CERP, the benefits may range from relatively insignificant to potentially substantial improvements in harvest rates thus benefiting the fishing industry.

4.2.7 Demographics and Environmental Justice

In terms of Demographics and Environmental Justice, no adverse cumulative economic impacts are expected as a result of the comprehensive stormwater program or the CERP. However, as described in Sections 3.8 and 1.2.6, implementation of the MCSWMP throughout the Keys would generally increase wastewater management costs for residents. Based on the information in Section 3.8.1.3, it was determined that the low-income population could not afford an increase in wastewater management costs over present costs. When combined with the high cost of living in the Keys, the cumulative impact of implementing the wastewater program may result in disproportionate adverse economic effects on low-income populations. These impacts would depend on system costs, the grant funding and financing options related to the capital costs of wastewater improvement projects, and the availability of funding from assistance programs targeted to low-income service recipients.

The siting of WWTP and other wastewater facilities is not expected to cause cumulative adverse effects to minority and/or low-income populations in the Keys, when combined with the above concurrent projects.

4.2.8 Hazardous Materials

Potential cumulative effects on hazardous materials as they relate to the projects described in Section 4.1 are expected to be minimal.

4.2.9 Infrastructure

WWTP construction or upgrade and OWTS conversion to clustered OWNRS as part of the MCSWMP implementation, along with implementation of the MCSMMP would result in a cumulative increase of the infrastructure required for these projects. However, adverse cumulative effects on Monroe County's overall infrastructure, as described in Section 4.1, are expected to be minimal.

4.2.10 Land Use and Planning

The installation of new WWTPs, upgrading of WWTPs, and conversion of OWTS to OWNRS as part of comprehensive wastewater management is not expected to cause changes in the existing growth pattern of the region. The capacity of wastewater treatment alternatives proposed in the MCSWMP are based on accommodating a 17% increase in residential wastewater use and 7% increase in non-residential use over a 20-year planning period (1998 to 2018). As is typical for capital-intensive projects that have project lives in excess of 10 years, the capacity of proposed wastewater management projects take into account future demand for wastewater disposal. As described in Section 3.10, these growth projections are based on the present ROGO permitting system that limits growth in Monroe County. Changes to the rate of growth and building permit allocation system are at the discretion of the Monroe County BOCC and the Florida DCA.

The impact of improved wastewater and stormwater management and CERP on CARL lands and conservation lands, and areas managed under the CZMA would depend on the siting of individual projects in relation to these lands. Conscientious siting of projects outside of these lands, compliance with CZMA, and the implementation of mitigation measures would assist in reducing adverse cumulative effects on these special status lands. Proposed projects identified in this PEA are not eligible for FEMA funding if sited in or serving areas that are CBRS units; therefore there would be no cumulative impacts on CBRS units. In terms of the positive effects on ground water and nearshore waters identified in Section 3.2 of this PEA, the proposed WWTP should result in generally positive effects on the natural resource value of CARL and conservation lands, CBRS units, and coastal areas that derive their natural resource value from good water quality.

4.2.11 Noise and Visual Resources

Potential cumulative effects on noise and visual resources as they relate to the projects described in Section 4.1 are expected to be minimal.

The topic of wastewater management improvements and water quality degradation in the Keys is of particular public interest to agencies and citizens alike. For this reason, public participation throughout the PEA and SER processes is of high concern not only in terms of upholding the intent of NEPA and other applicable environmental statutes, but also to ensure that FEMA conducts studies with the knowledge that public and agency opinions were gathered and considered, ensuring a well-documented and well-represented study. FEMA has specific requirements for public participation in compliance with its implementing regulations for NEPA, EO 11988 (Floodplain Management) and EO 11990 (Wetland Protection); and EO 12898 (Environmental Justice).

FEMA's public involvement activities began with notification of the PEA preparation as part of the scoping process. Public notification was issued via a Notice of Intent (NOI) published in the Key West Keynoter, the Key West Citizen, and The Reporter newspapers from the end of August through September 10, 2000 (Appendix G). Since publication of the NOI, FEMA has received comments from interested parties pertaining to the proposed wastewater improvement projects. FEMA has considered these concerns during preparation of the PEA as they relate to NEPA and the environmental review process.

In addition to initiating public involvement, FEMA has notified relevant Federal, State and local agencies of preparation of this PEA through a agency coordination letters sent on August 15, 2001. The letters provided brief descriptions of FEMA's funding mechanism, the NEPA review process, proposed project alternatives; and invited agencies to provide preliminary comments on the information therein. To date, only four agencies responded to this letter; their responses are in Appendix G.

In accordance with FEMA procedures and NEPA public noticing requirements, a draft version of the PEA was advertised in local newspapers and available at local repositories for a 30-day comment period from September 20 to October 18, 2002. A copy of the public notice is contained in Appendix I. During this review period, two public meetings were held on October 8 and October 9, 2002 at the Key Largo Branch Library and Marathon Government Center, respectively. The meetings were administered by FEMA to outline FEMA's environmental review process, provide an overview of draft PEA conclusions, and provide an opportunity to discuss, comment on and suggest refinements to the draft PEA. Representatives from DCA, Monroe County, FKAA, Village of Islamorada, USACE, and URS Group presented information and were available to respond to questions from the public.

Interested parties had the opportunity to submit comments on the draft PEA by mail, in-person at the public meetings, by fax, and electronically on the PEA website. A total of three individuals and one agency submitted letters by mail. Five individuals submitted comments through the PEA website. At the public meetings on October 8 and 9, there were six and seven participants, respectively. Public comments submitted to FEMA during the 30-day review period were reviewed and addressed, as appropriate, in this PEA document. A compilation of all comments and responses are contained in Appendix K. In total, 76 individual comments were received, analyzed, and addressed.

Similar to this PEA, preparation of the project-specific SERs will include a public outreach component. Draft versions of the SER will be made available for public comment before issuance of the final document. Additional forms of public outreach may include public meetings, the

posting of notices and other relevant information via the Internet, as well as project information disseminated through local media outlets.

Public involvement has also been an integral element of Monroe County's wastewater planning process and the development of the MCSWMP. Public involvement activities conducted as part of the MCSWMP included over 30 meetings with key stakeholders and the public hosted by the FKAA and the County held between 1998 and 2000; public forums in the Upper, Middle, and Lower Keys; press releases to the media; distribution of fact sheets outlining key project milestones and other project-related information; presentations at Monroe County BOCC meetings; radio talk show appearances; project video presentations; and a school-based outreach program among other modes of public involvement. Participants providing comments generally expressed concerns regarding implementation costs, extent of improved water quality, implementation approaches, alternative conveyance/treatment technologies, measuring project performance, and County responsiveness to public input. Additional details on the public involvement associated with the development of Monroe County's wastewater management planning, including the decision analysis for alternatives, can be found in the MCSWMP (Monroe County, 2000a).

The construction and operation of the wastewater treatment projects, as proposed in this PEA, would result in some limited adverse impacts and long-term positive impacts to the human environment. The majority of adverse impacts would be short-term and construction-related. Effects to topography, soils, and geology; air quality; cultural resources; hazardous materials and wastes; infrastructure; land use and planning; and noise and visual resources are expected to be negligible.

Impacts to water resources and water quality are expected to be positive with the improvement of inland, nearshore, and offshore water quality. The implementation of the proposed projects would result in increased wastewater management costs, particularly to service recipients who currently have cesspits or septic tanks. The increase in wastewater management costs could have a highly disproportionate and adverse economic effect on low-income service recipients. However, grant funding assistance is expected to reduce the capital costs so that the wastewater service would be affordable for service recipients. Assistance guidelines have been outlined to further reduce the economic impact of wastewater projects to qualified low-income service recipients for FEMA-funded projects.

With the implementation of the mitigation measures and conditions outlined in this PEA, along with the applicable permitting, impacts to the human environment are expected to be less than significant. This conclusion is based on the analyses, conditions, and assumptions contained in the PEA. To assess the project- and location-specific impacts, FEMA will prepare an SER for each individual project. The project applicants would be required to follow the conditions and mitigation measures outlined in this PEA in addition to any project- and location-specific requirements.

Project Management and Technical Research

Erica Zamensky, URS Group, Inc., Project Manager, Project Environmental Scientist. Ms. Zamensky has 10 years of experience in Natural Resources Management and Planning, with 8 of those years in managing NEPA documentation projects of varying scopes. Project experience includes stormwater, construction of dams and reservoirs, floodwalls, retention and detention ponds, and hydraulic improvements to river and streams, as well as in construction of public housing, schools, and pump stations. Ms. Zamensky has experience in managing small and large teams in fieldwork operations, technical topic research, and document writing relative to NEPA and other natural resource planning and management tasks. Ms. Zamensky serves as Project Manager, technical researcher, and document author.

Jonathan Randall, URS Group, Inc., Senior Environmental Scientist. Mr. Randall has more than 5 years of experience, with specialized expertise in NEPA compliance studies, Section 7 Endangered Species Act biological assessments, ecological field surveys and natural resource studies, quantitative policy analyses, and technical writing and editing. In compliance with FEMA's implementing regulations, he has prepared a broad range of NEPA documentation, including assessments for natural hazard mitigation projects such as school building relocations, stream bank stabilizations, detention basins, and fuels modification and management. He serves as assistant project manager, technical researcher, and document author.

George H. Davis, P.G., URS Group, Inc., Principal Hydrogeologist. Mr. Davis is a hydrogeologist who has been with URS (formerly Woodward Clyde Consultants) since 1985 following a 32-year career with the U.S. Geological Survey. His USGS career culminated with 3 years' service as Assistant Director of the agency. His more than 40 years of experience comprises groundwater and surface water hydrology, water supply studies, and water contamination investigations; and includes field investigations, remedial investigations, and feasibility studies of contaminated sites, regulatory agency interactions, and siting and permitting of radioactive, hazardous, and municipal waste projects. He has had extensive experience at public and regulatory hearings, and as an expert witness in court proceedings. His extracurricular activities include service on International and National Research Council committees, and as managing editor of *Water Resources Research* and *Journal of Hydrology*. Mr. Davis serves as technical researcher and document author.

Thomas W. Bodor, URS Group, Inc., Senior Archeologist. Mr. Bodor has 12 years of experience in cultural resource management, with a focus on prehistoric and historical archaeology. He has completed all levels of archaeological investigations for Federal, State, and local clients in the Mid-Atlantic, Midwest, Southeast, and Southwest regions of the United States. A majority of recent projects includes the preparation of documents in compliance with Section 106 of the National Historic Preservation Act, and other Federal regulations. Mr. Bodor serves as technical researcher and document author.

Joyce Friedenber, URS Group, Inc., Economist. Joyce Friedenber recently joined URS after having worked as a production economist for four years at a multinational corporation. She has worked overseas as an advisor and extension agent in community economic development and in the mid-west as a small business researcher, specializing in project profitability assessment. Prior to her training and experience as an economist, Ms. Friedenber worked as a water resource engineer, analyzing agricultural, domestic and commercial water use efficiency for the U.S.

Department of Agriculture and for the Colorado Water Resources Research Institute. Ms. Friedenberg serves as lead economic analyst and document author.

Sonya Krogh, URS Group, Inc., GIS Analyst/NEPA Research Assistant. Sonya Krogh has 4 years experience in Geographic Information Systems (GIS), environmental geography, natural resource management, environmental justice, water resources management, conservation, and ecology. Ms. Krogh serves as lead GIS Analyst, technical researcher, and document author.

Technical Peer Review

Colin Vissering, AICP, URS Group, Inc., Master Planner and Environmental Resource Management Department Head. Mr. Vissering is a senior planner with experience in environmental and urban planning, policy, and emergency management and hazard mitigation programs. He has managed environmental and cultural resource compliance activities for Federal disaster programs, providing oversight for numerous NEPA Environmental Assessments and related natural resource studies. His experience includes development of hazard mitigation plans and related planning guidance, environmental training, Federal environmental regulatory and policy development, and drafting and implementation of National Historic Preservation Act (NHPA) agreement documents. Mr. Vissering is currently the department head of the Environmental Resource Management Group for URS in Gaithersburg, Maryland. This group is comprised of the landscape architecture/planning, cultural resource management, and NEPA and natural resource management teams. Mr. Vissering serves as document peer reviewer.

Daniel M. Savercool, URS Group, Inc., Senior Ecologist and Ecological Resources Group Manager. Mr. Savercool has over 19 years experience in the ecology, restoration and creation of freshwater and estuarine marshes, mangrove forests, seagrass meadows and adjacent upland habitats. Over 15 years of this experience is focused on coastal plant and estuarine benthic communities of peninsular Florida, with particular expertise in the Everglades and the Keys. He has studied plant and animal colonization of recently restored or impacted coastal habitats, experimental revegetation of wetlands utilizing both marine and freshwater species and management techniques for the control of undesirable exotic vegetation. Mr. Savercool's published research includes artificial reefs, estuarine benthic communities and control of exotic vegetation in Florida. He serves as technical peer reviewer for the biological resources sections of the PEA.

Michael S. Knapp, P.G., L.S. Sims and Associates, Inc., Consulting Geologist. Mr. Knapp is a hydrogeologist with over 27 years of specialized experience in well site geological evaluations, Underground Injection Control permitting, aquifer performance tests, and geophysical log interpretation with the majority of his experience in the State of Florida. Prior to joining L.S. Sims and Associates, Mr. Knapp served as President of HydroDesigns, Inc., Senior Hydrogeologist for the SFWMD, and District Geologist for the Florida Geological Survey. He has worked extensively with FDEP in the permitting aspects of underground injection wells, and is considered an expert on Florida Stratigraphy. Mr. Knapp serves as a technical peer reviewer of the topography, geology, and soils, and water quality and water resources sections of the PEA.

Thomas Kwader, Ph.D., P.G., URS Group, Inc., Hydrogeologist and Vice President. Dr. Kwader has worked extensively as a hydrogeologist in the Southeastern Coastal Plain of the United States in his over 25 years of experience. In the early 1980s, he was one of the 12 members appointed by the Florida Department of Environmental Regulation (now FDEP) to serve on the Technical Advisory Committee to develop the Underground Injection Control rule

for primacy in the State of Florida to address the underground injection of wastewater in Florida. Dr. Kwader is considered an expert in most all types of well construction and borehole geophysical logging, having personally logged a wide range of sewage effluent and high-pressure industrial injection wells. He is technical editor of the professional journal, *Groundwater*, and a member of the committee that developed the hydrostratigraphic units currently used in Florida. Dr. Kwader serves as a technical peer reviewer of the topography, geology, and soils, and water quality and water resources sections of the PEA.

FEMA Technical and Editorial Review

William Straw, Ph.D., FEMA Region IV, Regional Environmental Officer. Dr. Straw has managed and conducted FEMA regional environmental and cultural resource operations, reviews, field surveys, project planning and design, regulatory coordination and compliance, document preparation, public involvement, and other actions for a wide variety of construction, repair, restoration, reconstruction, elevation, upgrade, demolition, and other projects for 10 years. He has also developed and helped develop new and revised agency regional and national policies, procedures, publications, and training courses; helped State emergency management agencies develop their environmental operations capabilities; and managed Disaster Field Office environmental operations throughout the Southeastern U.S. His 27-year career in the earth and environmental sciences also includes seven years with the U.S. Army, three years in academia, and six years with a major architecture and engineering firm. He has degrees in earth sciences, geography, and ecology. Dr. Straw serves as senior overall peer, technical, and editorial reviewer for this document, and as the FEMA environmental determination authority for the proposed projects.

Science Kilner, FEMA Region IV, Lead Environmental Specialist and Project Monitor. Ms. Kilner has managed and conducted FEMA environmental and cultural resource reviews, field surveys, regulatory coordination and compliance, documentation, public involvement, and other actions for a wide variety of construction, repair, restoration, reconstruction, elevation, upgrade, demolition, and other projects for five years. She has also managed Disaster Field Office environmental operations in Florida and other southeastern states; and helped develop and revise agency environmental and cultural resource policies, procedures, and training courses at the regional and national levels. Her 10-year career includes five years as a cultural resources consultant in the Southeastern U.S. Ms. Kilner holds a bachelor's degree in archaeology and a graduate degree in environmental planning. Her specialized experience includes managing and preparing NEPA, ESA Section 7, and NHPA Section 106 regulatory compliance documents. Ms. Kilner serves as overall peer, technical, and editorial reviewer for this document; and as aide and advisor to the Regional Environmental Officer.

- Aguirre, A.A. 1998. Fibropapillomas in Marine Turtles: A Workshop at the 18th Annual Symposium on Biology and Conservation of Sea Turtles. Marine Turtle Newsletter. 82: 10-12.
- Ayres Associates. 1998. Florida Keys Onsite Wastewater Nutrient Reduction Systems Demonstration Project. Final Report. March.
- Barada, W. and W.M. Partington, Jr. 1972. Report of investigation of the environmental effects of private waterfront canals. Environmental Information Center, Florida Conservation Foundation, Inc. 63 pp. As cited in Kruczynski, 1999.
- Balazs, G.H., et al. 1997. Occurrence of Oral Fibropapillomas in the Hawaiian Green Turtle: Differential Disease Expression. Marine Turtle Newsletter. 76: 1-2.
- Beaver, Rick. 2001. Fishery Specialist, Florida Institute of Marine Fisheries, Fish and Wildlife Conservation Commission. Personal communication with Sonya Krogh, URS Group, Inc.
- Bell South. 2001. Personal communication with Joyce Friedenberg, URS Group, Inc., November 2, 2001.
- Berard, Ms. 2002. Monroe County Housing Authority. Personal communication with Joyce Friedenberg, URS Group, Inc., March 14, 2002.
- Bergin, Tim. 2001. Director of Engineering Division, Environmental Services Department. Florida Keys Aqueduct Authority. Personal communication with Joyce Friedenberg, Sonya Krogh, Jonathan Randall, URS Group, Inc.
- Bibler, Bart. 2001. Florida Department of Health. Personal communication with Erica Zamensky, URS. September 4.
- Branch, M.C., et al. 1970. Outdoor Noise and the Metropolitan Environment. Sound Levels and Relative Loudness of Typical Noise Sources in Indoor and Outdoor Environments. Los Angeles, California.
- Briggs, Gerald. 2001. Chief, Bureau of Onsite Sewage Programs, Florida Department of Health. Personal communication with Sonya Krogh, URS Group, Inc.
- Brookman, Bill. 2001. Environmental Health Supervisor. Monroe County Health Department. Personal communication with Sonya Krogh, URS Group, Inc.
- Brown, Steve. 2001. Fishery Specialist, Florida Institute of Marine Fisheries, Fish and Wildlife Conservation Commission. Personal communication with Sonya Krogh, URS Group, Inc.
- Caffry, Wendy. 2001. Medical Technologist, Lower Keys Medical Center. Personal communication with Jonathan Randall, URS Group, Inc.
- Canadian Centre for Occupational Health and Safety (CCOHS). 1999. Physical Agents, Noise – Basic Information. June 3. Accessed from www.ccohs.ca/oshanswers/phys_agents/noise_basic on Sept. 21, 2001.
- Capell, Dave. 2001. Roads and Bridges Department, Monroe County Public Works. Personal communication with Sonya Krogh, URS Group, Inc.
- Carney, Patricia. 2001. Consulting Engineer. Post, Buckley, Schuh, and Jernigan. Personal communication with Sonya Krogh, URS Group, Inc.

- Casey, Rick 2002. Monroe County Dept. of Housing. Personal correspondence with Joyce Friedenber, June 21 and July.
- Cates, Jolynn, Engineering Department, FCAA. Fax transmittal regarding a URS Greiner study conducted in March 1999 on visiting tourists in the Florida Keys. February 23, 2001.
- Chafin, L.G. 2000. *Field Guide to the Rare Plants of Florida*. Florida Natural Areas Inventory (FNAI), Tallahassee, Florida.
- Chiappone, M. and K. M. Sullivan. 1994. Ecological structure and dynamics of nearshore hard-bottom communities in the Florida Keys. *Bulletin of Marine Science* 54(3):747-756.
- Chiappone, M. and K. M. Sullivan. 1996. Functional ecology and ecosystem trophodynamics. Site Characterization for the Florida Keys National Marine Sanctuary and Environs, Volume 8. The Preserver, Zenda, Wisconsin.
- Chiappone, M. 1996. Marine Benthic Communities of the Florida Keys. Volume 4, In: Site Characterization for the Florida Keys National Marine Sanctuary and Environs. The Preserver, Zenda, Wisconsin.
- City Electric. 2001. Personal communication with Joyce Friedenber, URS Group, Inc. November 2.
- Cook, C. 1997. Reef corals and their symbiotic algae as indicators of nutrient exposure. Final Report submitted to the Water Quality Protection Program as cited in Kruczynski, 1999.
- Corbett, D.R., J. Chanton, W. Burnett, K. Dillion, and C. Rutowski. 1999. Patterns of groundwater discharge into Florida Bay, *Limnology Oceanography*, 44:1045-1055.
- D and D Enterprises, Inc. 2001. Personal communication with Joyce Friedenber, URS Group, Inc.
- De Freese, D. E. 1991. Threats to Biological Diversity in Marine and Estuarine Ecosystems of Florida. *Coastal Management*. Pgs. 73-101.
- Dunnick, J.D., et al. 1993. *Journal of the National Cancer Institute*. Assessment of the Carcinogenic Potential of Chlorinated Water: Experimental Studies of Chlorine, Chloramine, and Trihalomethanes. Vol. 85: 817-822. Assess from <http://jncicancerspectrum.oupjournals.org> on March 15, 2002.
- Dustan, P., 1999, Coral reefs under stress: sources of mortality in the Florida Keys Natural Resources Forum 23 (1999) 147-155
- Earle, J.E. and F.W. Meyer. 1973. Reconnaissance of the Water Resources in the Vicinity of Proposed Deep-Well Injection Sites in Southeast Dade County, Florida. Published by U.S. Geological Survey. Open File Report #73031.
- Edds, Jim. 2001. Division of Air Resource Management, Florida Department of Environmental Protection Agency. Personal communication with Sonya Krogh, URS Group, Inc.
- English, D.B.K., W. Kriesel, V.R. Leeworthy, and P. Wiley. 1996. Economic contribution of recreating visitors to the Florida Keys/Key West. *Linking the Economy and Environment of Florida Keys/Florida Bay*. NOAA, The Nature Conservancy, Monroe County Tourist Development Council, p.22

- EnviroTools, Inc. 1998. Threatened and Endangered Species Software (TESS 2.0). Gainesville, Florida.
- Federal Emergency Management Agency (FEMA). 1999. National Flood Insurance Program, Consolidated CBRA Q3 Electronic Flood Hazard Data. Diskette 4. Florida and Georgia.
- Fernandez, E. David. 2001. Utilities Director, Utilities Department, City of Key West. Personal communication with Jonathan Randall, URS Group, Inc.
- Fleisher, J. et al. 1998. Estimates of the Severity of Illnesses Associated with Bathing in Marine Recreational Waters Contaminated with Domestic Sewage. *International Journal of Epidemiology*. 1998; 27:72-726.
- Florida Committee on Rare and Endangered Plants and Animals (FCREPA). 1992a. *Rare and Endangered Biota of Florida, Volume I. Mammals*. University Press of Florida, Gainesville, Florida.
- _____. 1992b. *Rare and Endangered Biota of Florida, Volume II. Fishes*. University Press of Florida, Gainesville, Florida.
- _____. 1992c. *Rare and Endangered Biota of Florida, Volume III. Amphibians and Reptiles*. University Press of Florida, Gainesville, Florida.
- Florida Department of Environmental Protection (FDEP). 2002. Everglades Restoration Overview. Accessed from <http://www.dep.state.fl.us/secretary/everglades/default.htm> on March 26, 2002.
- _____. 2001a. Wastewater: Underground Injection Control Program. Accessed from <http://www.dep.state.fl.us/water/wastewater/uic/index.htm>.
- _____. 2001b. Drinking Water: Miscellaneous Contaminants. September 25. Accessed from http://www.dep.state.fl.us/water/drinkingwater/st_misc.htm on March 13, 2002.
- _____. 2001c. Wastewater: UV Disinfection of Wastewater. October 10. Accessed from <http://www.dep.state.fl.us/water/wastewater/dom/domuv.htm> on March 15, 2002.
- _____. Division of Air Resource Management. 2000. "EPA Aerometric Information Retrieval System (AIRS), Air Quality Subsystem, Quick Look Report." Accessed from <http://www.dep.state.fl.us/air/info/allsum/all00.htm> on September 14, 2001.
- _____. 1999. Air Monitoring Report, Division of Air Resource Management. Accessed from <http://www8.myflorida.com/environment/publications/air/techrpts/techrpts.html#allsum> on September 14, 2001.
- _____. 1985. Proposed designation of the waters of the Florida Keys as Outstanding Florida Waters. Report to the Florida Environmental Regulatory Commission. FDER, 57 pp. as cited in Kruczynski, 1999.
- Florida Department of Health (FDH). 2001a. Florida Administrative Code, Chapter 64E-5, Standards for Onsite Sewage Treatment and Disposal Systems. Accessed from <http://www9.myflorida.com/environment/OSTDS/form/docfiles/forms/64e6.doc>
- Florida Department of Health (FDH). 2001b. Public Health Indicators System. Accessed from http://www.doh.state.fl.us/planning_eval/phstats/index.html on September 18, 2001.

- Florida Department of Historic Resources (FDHR). 2001. Florida Historical Context. Accessed from dhr.dos.state.fl.us/bar/hist_contexts/wwwcalch.doc
- Florida Game and Fish Commission (FGFC). 1997. *Florida's Endangered Species, Threatened Species and Species of Special Concern – Official Lists* (<http://www.state.fl.us/gfc/pubs/endanger.html>). Tallahassee, Florida.
- Florida Keys Aqueduct Authority (FKAA). 2001a. System Overview. Accessed from <http://www.fkaa.com/system.htm> on September 10, 2001.
- _____. 2001b. Personal communication with Joyce Friedenber, URS Group, Inc. November 2.
- _____. 2002. Project Feasibility Report Regarding The Marathon Central Wastwater Facilities Program . Faxed to Joyce Friedenber by Jack Teague, July 1.
- Florida Keys Electric Cooperative (FKEC). Information, 2000. Accessed from <http://www.fkec.com/info.html> on October 4, 2001.
- Florida Keys National Marine Sanctuary (FKNMS). 2001. Water Quality Protection Program Overview. Accessed from www.fknms.nos.noaa.gov/research_monitoring/wqpp.html on August 9, 2001.
- Florida Keys Virtual Traveler. 2001. "History of the Florida Keys." Information on Keys history gathered from Internet site. Site visited February 26, 2001.
- Florida Marine Research Institute (FMRI) Technical Report TR-4. 2000. Benthic Habitats of the Florida Keys. In association with the National Oceanic and Atmospheric Administration and the Florida Fish and Wildlife Conservation Commission
- _____. 1998. Ocean Planning and Governance Geographic Information System. National Oceanic and Atmospheric Administration. Charleston, South Carolina.
- Florida State Historic Preservation Office (FSHPO). 1993. State of Florida Comprehensive Preservation Plan (<http://dhr.dos.state.fl.us/bar/hist-contexts/comp-plan.pdf>)
- Folk, M.L., W.D. Klimstra and C. Kruer. 1991. Habitat evaluation, national Key deer range. Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Project No. NG88-015. Tallahassee, Florida.
- Fonseca, A.S., W. J. Kenworthy and G.W. Thayer. 1998. Guidelines for the conservation and restoration of seagrasses in the United States and adjacent waters. NOAA Coastal Ocean Program Decision Analysis Series No. 12. NOAA Coastal Ocean Office, Silver Spring, MD. 222 pp.
- Garrett, George. 2001. Director of Marine Resources, Monroe County. Personal communication with Jonathan Randall, URS Group, Inc.
- Griffin, Dale W., Gibson III, Charles J., Lipp, Erin K., Riley, Kelley, Paul III, John H., and Rose, Joan B. 1999. Detection of Viral Pathogens by Reverse Transcriptase PCR and Microbial Indicators by Standard Methods in the Canals of the Florida Keys. *Applied and Environmental Microbiology*. 65:4118-4125.
- Halley, R.B., Vacher, H.L., and Shinn, E.A., 1997, Geology and hydrology of the Florida Keys in *Geology and Hydrology of Carbonate Islands, Developments in Sedimentology* 54, pp. 217-248. Elsevier Science B.V., Amsterdam.

- Hallock, P., Muller-Karger, F.E., Halas, J.C. 1993. Coral Reef Decline. National Geographic Research & Exploration. 9(3):358-378.
- Head, Lee, Madelene Mayhall, Alan Tucker, and Jeffrey Caffey. 2001. "Low Pressure Sewer System Replaces Septic System in Lake Community." Published by E/One Sewer Systems. Accessed from <http://www.eone.com/sewer/resources/resource01/content.html> on August 8.
- Hickey, John J. 1984. Subsurface Injection of Treated Sewage into a Saline Water Aquifer at Saint Petersburg, Florida. Aquifer Pressure Buildup. Ground Water. 22(1): 48-55. January-February.
- Hipes, D., D.R. Jackson, K. NeSmith, D. Printiss, and K. Brandt. 2000. *Field Guide to the Rare Animals of Florida*. Florida Natural Areas Inventory, Tallahassee, Florida.
- Hurt, G.W., Noble, C.V., and Drew, R.W., 1995, Soil Survey of Monroe County, Keys Area, Florida. U.S. Dept. of Agriculture, Natural Resources Conservation Service, 72 p.
- Islamorada, Village of. 2001a. Design/Build/Operate Wastewater Management System(s) plans. Prepared by Florida Water Services and PBS&J. Project No. 00-0207.
- Islamorada, Village of. 2001b. Islamorada Wastewater Management Due Diligence Evaluation. Prepared by Arcadis G&M, Inc. July 12.
- Islamorada, Village of. 2001c. Wastewater Treatment System Conceptual Design Report – Plantation Key Colony / North Plantation Key. Prepared by Florida Water Services and PBS&J. Project No. 011259. July 03
- Jaap, W.C. 1984. The ecology of the south Florida coral reefs: a community profile. U.S. Fish and Wildlife Service Report Number FWS/OBS-82/08, Office of Biological Services, Washington D.C. 138 pp.
- Jetton, Rebecca. 2001. Planning Manager, Marathon Regional Service Center, Florida Department of Community Affairs. Personal communication with John Randall, URS Group, Inc.
- Johnson, A.F. and M.B. Barbour. 1990. Dunes and maritime forests. Pp 429-480 *In*: R.L. Myers and J.J. Ewel (eds.). *Ecosystems of Florida*. University of Central Florida Press. Orlando, Florida.
- Johnson's Insurance 2002. Customer service representative. Personal correspondence with Joyce Friedenber, URS Group, Inc.
- Jones, Ronald and Joseph Boyer. 2001. Water Quality Monitoring Project: FY 2000 Annual Report. Published by the Southeast Environmental Research Center, Florida International University under contract to EPA.
- Kale, H.W, and D.S. Maehr. 1990. *Florida's Birds: A Handbook and Reference*. Pineapple Press, Sarasota, Florida.
- Karnatz, Laurie. 2000. "Report IDs contaminated waters." Florida Keys Keynoter. June 10.
- Key Colony Beach. 2002. Ed Borysiewicz, Building Official. Personal communication with Joyce Friedenber of URS Group, Inc. September 10.

- Key Haven Utilities. 2002. Personal communication with Joyce Friedenbergh of URS Group, Inc. March 14.
- Key West, The City of. 2002. David Fernandez, Utilities Director. Personal communication with Joyce Friedenbergh of URS Group, Inc. September 10
- The Key West Citizen. 2001. Classified page. <http://keysnews.com> Accessed November 2, 2001.
- Klein, Paul A. 1998. Association of a Unique Chelonid Herpesvirus with Sea Turtle Fibropapillomas. *Marine Turtle Newsletter*. 80:14.
- Klineman, Keith. 2002. Head of Domestic Wastewater Section, Fort Myers District Office, Florida Department of Environmental Protection (DEP). Personal communication with Lisa Fretwell, URS Group, Inc.
- Kohout, F.A. 1965. A hypothesis concerning cyclic flow of salt water related to geothermal heating in the Floridan aquifer: *New York Academy of Sciences Transactions, Series 2*. 28(2): 249-271.
- Komulainen, et al. 1997. *Journal of the National Cancer Institute*. Carcinogenicity of the Drinking Water Mutagen 3-chloro-4- (dichloromethyl)-5-hydroxy-2(5H)-furanone in the Rat. Vol. 89: 848-856. Oxford University Press. Assessed from <http://jncicancerspectrum.oupjournals.org> on March 15, 2002.
- Kozma, Danah. 2001. Representative, Monroe County Tourist Development Council. Personal communication with Jonathan Randall, URS Group, Inc on August 30.
- Kruczynski, William. 1999. Water Quality Concerns in the Florida Keys: Sources Effects, and Solutions. Florida Keys National Marine Sanctuary Water Quality Protection Program, National Oceanographic and Atmospheric Administration.
- Kurz, R.C. et al. 1999. Summary of recent trends in seagrass distributions in southwest Florida coastal waters. South Florida Water Management District. Surface Water Improvement and Management Program - Technical Report.
- Kushlan, J.A. 1990. Freshwater marshes. Pp. 324-363 *In*: R.L. Myers and J.J. Ewel (eds.). *Ecosystems of Florida*. University of Central Florida Press. Orlando, Florida.
- Lapointe, B.E. and W.R. Matzie. 1996. Effects of Stormwater Nutrient Discharge on Eutrophication Processes in Nearshore Waters of the Florida Keys. *Estuaries*. 19: 422-435.
- Lapointe, B.E., D.A. Tomasko, and W.R. Matzie. 1994. Eutrophication and trophic state classification of sea grass communities in the Florida Keys. *Bulletin of Marine Science* 54: 696-717.
- Lapointe, Brian and Mark Clark. 1992. Nutrient Inputs from the Watershed and Coastal Eutrophication in the Florida Keys. *Estuaries*. 15(4): 465-476. December
- Lapointe, Brian, Julie O'Connell, George Garrett. 1990. Nutrient couplings between on-site sewage disposal systems, groundwaters, and nearshore surface waters of the Florida Keys. *Biogeochemistry*. 10: 289-307.
- Lazar, Ann. 2001. Department of Community Affairs. Personal communication with Sonya Krogh, URS Group, Inc. September 10.

- Leckler, Kurt. 2001. Permit Compliance Specialist, South Florida Water Management District. Personal communication with Jonathan Randall, URS Group, Inc.
- Leeworthy, V.R. and J.M. Bowker. 1997. Nonmarket Economic User Values of the Florida Keys/Key West. Linking the Economy and Environment of Florida Keys/Florida Bay. NOAA, The Nature Conservancy, Monroe County Tourist Development Council. 41 pp.
- Leeworthy, V.R. and P. Wiley. 1996. Importance and Satisfaction Ratings by Recreating Visitors to the Florida Keys/Key West. Linking the Economy and Environment of Florida Keys/Florida Bay. NOAA, The Nature Conservancy, Monroe County Tourist Development Council. 23 pp.
- Leeworthy, V.R. and Patrick Vanasse. 1999. Economic Contribution of Recreating Visitors to the Florida Keys/Key West: Updates for the Years 1996-97 and 1997-98. Linking the Economy and Environment of Florida Keys/Florida Bay. NOAA, The Nature Conservancy, Monroe County Tourist Development Council. 20 pp.
- Lindeman, K.C. 1997. Development of Grunts and Snapper of Southeast Florida: Cross-Shelf Distribution and Effect of Beach Management Alternatives, PhD dissertation, University of Miami, Coral Gables, FL.
- Livingston, R.J. 1990. Inshore marine habitats. Pp 549-573 *In*: R.L. Myers and J.J. Ewel (eds.). Ecosystems of Florida. University of Central Florida Press, Tampa.
- Long, R.W., and O. Lakela. 1971. *A Flora of Tropical Florida*. University of Miami Press, Coral Gables, Florida.
- Lucas, Robert B. 2001. Waste and Chemical Processes Group, U.S. Environmental Protection Agency. Personal communication with Sonya Krogh, URS Group, Inc.
- Lugo, A. F. and S. C. Snedaker. 1974. The Ecology of Mangroves. *Annual Review of Ecology and Systematics*. 5:39-64.
- Maguire, James R. 1999. Review of the Persistence of Nonylphenol and Nonylphenol Ethoxylates in Aquatic Environments. *Water Quality Research Journal of Canada*. 34(1): 37-38
- Marsh, William. 1991. *Landscape Planning Environmental Applications*, Second Edition. John Wiley and Sons, Inc. New York.
- McGarry, Tim. 2002. Director of Growth Management, Monroe County Planning Dept., Personal communication with Kristin Kilby, URS Group, Inc., March 20.
- McNeese, P.L. 1998. Florida Keys Advance Identification of Wetlands (ADID) project technical summary document. Lewis Environmental Services, Inc., Summerland Key, Florida.
- McPherson, B.F. and Halley, Robert, 1996, The South Florida Environment---A region under stress. U.S. Geological Survey Circular 1134, 61 p.
- Meyer, Frederick W. 1989. Hydrogeology, Ground-water Movement, and Subsurface Storage in the Floridan Aquifer System in Southern Florida. U.S. Geological Survey Professional Paper 1403-G. U.S. Government Printing Office, Washington.
- Meyers, R. L. and J. J. Ewel (editors). 1990. *Ecosystems of Florida*. University of Central Florida Press., Orlando, Florida

- Miller, J.A. 1986. Hydrogeologic Framework of the Floridian Aquifer System in Florida and in Parts of Georgia, South Carolina and Alabama: U.S. Geological Survey Professional Paper 1403-B, p.91
- Mitchell Enos Septic Tank Corp. 2002. Personal communication with Joyce Friedenbergh, URS Group, Inc. March 14.
- Molins, Delphin. 2001. Florida Department of Transportation, Community Awareness Program Administrator. Personal communication with Sonya Krogh, URS Group, Inc.
- Monroe County. 2002. Florida Keys No Discharge Zone. Accessed from <http://www.co.monroe.fl.us/ndz/info.htm> on November 5, 2002.
- Monroe County. 2001a. Stormwater Management Master Plan. Prepared by Camp, Dresser and McKee, Inc., Keith and Associates, Inc. in association with Environmental Consulting Systems, Glen Boe and Associates, Mote Marine Laboratories, The Market Share Company, and Valerie Settles, Esq. Vol. 1 (February), 2 (August).
- _____. 2001b. District-level data on property taxes. Monroe County Property Appraiser.
- _____. 2000a. Monroe County Sanitary Wastewater Master Plan. Volume 1. Submitted by CH2MHILL. June.
- _____. 2000b. Monroe County Population, Estimates and Forecasts 1990 to 2015. Published by the Monroe County Planning Department. February.
- _____. 1997. Monroe County Year 2010 Comprehensive Plan. Adopted by the Monroe County Board of County Commissioners, Department of Community Affairs and Administration Commission of the State of Florida. September.
- Morris, R.D. et al. 1992. American Journal of Public Health. Chlorination, Chlorination By-products, and Cancer: A Meta-analysis. Vol. 82, Iss. 7: 955-963. American Public Health Association. Accessed from <http://ajph.org> on March 11, 2002
- National Marine Fisheries Service (NMFS). 2001. Endangered and Threatened Species and Critical Habitats under the Jurisdiction of the National Marine Fisheries Service. Florida-Atlantic Coast Region. Accessed from http://caldera.sero.nmfs.gov/protect/flac_can.htm on October 22.
- _____. 2000. Fisheries Statistics and Economics Division. Accessed from www.st.nmfs.gov on August 27, 2001.
- National Oceanic and Atmospheric Administration (NOAA). 2000. Interview with Billy D. Causey, Superintendent Florida Keys National Marine Sanctuary. Accessed from <http://newnos.nos.noaa.gov/seas/missions/florida2/background/interview.html> on August 24, 2001.
- _____. 1999. Commercial Fishing in the Florida Keys. Accessed from <http://sustainableseas.noaa.gov/missions/florida1/background/fishing.html> on August 24, 2001.
- National Research Council. 1993. Managing Wastewater in Coastal Urban Areas. National Academy Press. Washington, D.C.

- Nelson, G. 1994. *The Trees of Florida: A Reference and Field Guide*. Pineapple Press, Sarasota, Florida.
- Nelson, G. 1996. *The Shrubs and Woody Vines of Florida: A Reference and Field Guide*. Pineapple Press, Sarasota, Florida.
- Nobles, Robert E., Perry Brown, Joan Rose, Erin Lipp. 2000. The Investigation and Analysis of Swimming associated Illness Using the Fecal Indicator Enterococcus in Southern Florida's Marine Water. Florida Journal of Environmental Health. June.
- Noise Center of the League. 2001. Noise Levels in Our Environment Fact Sheet. Updated February 1. Accessed from www.lhh.org/noise/decibel on September 18, 2001.
- Noise Pollution Clearinghouse (NPC). 2001. Protective Noise Levels. Accessed from www.nonoise.org/library/levels on September 18, 2001.
- Ocean Reef Club, The. 2002. Personal communication with Joyce Friedenbergh of URS Group, Inc. March 14.
- Odum, W.E. and McIvor, C.C. 1990. Mangroves. Pgs. 517-548. *In*: R.L. Myers and J.J. Ewel (eds.). *Ecosystems of Florida*. University of Central Florida Press. Orlando, Florida.
- Patterson, K.L., Porter, J.W., Ritchie, K.B., Polson, S.W., Mueller, E., Peters, E.C., Santavy, D.L., and Smith, G.W. 2002. The etiology of white pox, a lethal disease of the Caribbean elkhorn coral, *Acropora palmata*. *Proceedings of the National Academy of Sciences*, 99:13, 8725-8730.
- Paul, J.P., J.B. Rose, S. Jiang, X. Zhou, P. Cochran, C. Kellogg, J. Kang, D. Griffin, S. Farrah, and J. Lukasik. 1997. Evidence for groundwater and marine water contamination by waste disposal wells in the Florida Keys. *Water Research* 31:1448-1454.
- Paul, J.P., J.B. Rose, J. Brown, E.A. Shinn, S. Miller and S.R. Farrah. 1995a. Viral tracer studies indicate contamination of marine waters by sewage disposal practices in Key Largo, Florida. *Appl. Environ. Microbiol.* 61:2230-2234.
- Paul, J.P., J.B. Rose, S. Jiang, C Kellogg, and E.A. Shinn. 1995b. Occurrence of fecal indicator bacteria in surface waters and the subsurface aquifer in Key Largo, Florida. *Appl. Environ. Microbio.* 61:2235-2241.
- Porter, J.W., and O.W. Meier. 1992. Quantification of loss and change in Floridian reef coral populations. *American Zoologist* 32:625-640.
- Reisinger, Niko. 2001. Monroe County Biologist, Monroe County Building and Planning. Personal communication with URS Group, Inc.
- Rios, Gus. 2001. Florida Department of Environmental Protection, Marathon District. Personal communication with Sonya Krogh, URS. September 10.
- Ross, M.S., J.J. O'Brien and L.J. Flynn. 1992. Ecological site classification of Florida Keys terrestrial habitats. *Biotropica* 24:488-502.
- Rudnick, D.T., Z. Chen, D.L. Childers, J.N. Boyer, T.D. Fontaine, III. 1999. Phosphorus and Nitrogen Inputs to Florida Bay: The Importance of the Everglades Watershed. *Estuaries*. 22(2B): 398-416.

- Sawicki, Sharon. 2002. Head of Domestic Wastewater Section, Florida Department of Environmental Protection (DEP). Personal communication with Lisa Fretwell, URS Group, Inc.
- Scurlock, J.P. 1987. *Native Trees and Shrubs of the Florida Keys: A Field Guide*. Laurel Press, Bethel Park, Pennsylvania.
- Sears Aerobic Service. 2001. Personal communication with Joyce Friedenber, URS Group, Inc., November 2.
- Sears Aerobic Service. 2002. Personal communication with Joyce Friedenber, URS Group, Inc. March 14.
- Shelby, Kerry. 2001. Assistant Director of Administration. Florida Keys Aqueduct Authority. Personal communication with Jonathan Randall, URS Group, Inc.
- Shelby, Kerry. 2002. Assistant Director of Administration. Florida Keys Aqueduct Authority. Personal communication with Jonathan Randall and Joyce Friedenber, URS Group, Inc.
- Shinn, Eugene, Ronald Reese, and Christopher Reich. 1994. Fate and Pathways of Injection-Well Effluent in the Florida Keys. Department of the Interior, U.S. Geological Survey. Open-file Report 94-276.
- Singh, Udai and Ross Sproul. 1980. Geotechnical Investigations During Drilling of a Deep Disposal Well in Dade County, Florida. *Ground Water*. 18(5): 498-502. September-October.
- Sleighter, Bobbie. 2002. Monroe County Health Department, Florida Department of Health. Personal communication with Joyce Friedenber, URS Group, Inc. March 14.
- Smith, Richard. 2001. Bureau of Water Facilities Funding, Florida Department of Environmental Protection. Personal communication with Jonathan Randall, URS Group, Inc.
- Snedacker, S.C. and Lugo, A.E. 1973. The Role of Mangrove Ecosystems in the Maintenance of Environmental Quality and a High Productivity of Desirable Fisheries. Final Rep. on Contract 14-16-008-606 to U.S. Bur. Sport Fish. Wildlife, Washington D.C.
- Snyder, J.R., A. Herndon and W.B. Robertson. 1990. South Florida rockland. Pp. 230-278 *In*: R.L. Myers and J.J. Ewel (eds.). *Ecosystems of Florida*. University of Central Florida Press. Orlando, Florida.
- South Florida Regional Planning Council (SFRPC). 2001. South Florida Municipalities Ranked by Absolute Population Growth 1990 to 2000. Accessed from <http://www.sfrpc.com/region/demographics.htm> on September 5, 2001.
- SSWMP. 1978. Management of Small Wastewater Flows. Small-scale Waste Management Project, University of Wisconsin, Madison. U.S. EPA report No. EPA/600/17-78-173. MERL, ORD. U.S. EPA, Cincinnati, Ohio.
- Stankiewicz, Tiffany. 2001. Planning Administrator. Monroe County Planning Department. Personal communication with Laura Dunleavy, URS Group, Inc. on December 10.
- Synagro / Accurate Enterprises of South Florida, Inc. 2001. Personal communication with Joyce Friedenber, URS Group, Inc. November 2.

- Szmant, A.M. and A. Forrester. 1996. Water Column and Sediment Nitrogen and Phosphorus Distribution Patterns in the Florida Keys. *Coral Reefs*. 15: 21-41.
- Taylor, Robert. Florida Bureau of Historic Preservation, Grants & Education Section. 2001. Personal communication with URS Group, Inc. regarding the status of Monroe County's predictive models in cultural resources. February 26.
- Teague, Jack 2001. Wastewater Programs Administrator, Florida Keys Aqueduct Authority. Personal communication with Sonya Krogh and Jonathan Randall, URS Group, Inc.
- Tindle, Greg. 2002. Deputy Village Manager, Village of Islamorada. Letter dated July 9, 2002.
- Tomlinson, P.B. 1986. *The Botany of Mangroves*. Cambridge University Press, London. 413 pp.
- Tummini, Tom. 2001. Monroe County Planning Department. Personal communication with URS Group, Inc.
- U.S. Army Corps of Engineers and Florida Department of Community Affairs (USACE/FDCA). 2001. Florida Keys Carrying Capacity Study. First Draft. Prepared by URS Corporation under USACE Contract Number DACW17-99-D-0058, Delivery Order #11, Test CCAM.
- U.S. Census Bureau (U.S. Census), 2001a. Money Income in the United States: 2000, Current Population Reports. Accessed from <http://www.census.gov/prod/2001pubs/p60-213.pdf> on November 20, 2001.
- _____. 2001b. Poverty 2000. Accessed from <http://www.census.gov/hhes/poverty/poverty00/thresh00.html> on July 3, 2002
- _____. 2000a. Current Population Survey. Accessed from <http://www.census.gov>.
- _____. 2000b. Profile of Selected Economic Characteristics: 2000, Geographic Area: Monroe County, Florida. Accessed from <http://www.census.gov/data/FL/05012087.pdf>
- _____. 2000c. Current Population Survey. Accessed from <http://www.census.gov>.
- U.S. Department of Agriculture (USDA) 1984. Plants for coastal dunes of the Gulf and South Atlantic coasts and Puerto Rico. USDA Agric. Info. Bull. 460. Washington, D.C.
- U.S. Department of Housing and Urban Development (HUD), 2002. FY 2002 Income Limits for the Public Housing and Section 8 Programs. Accessed from <http://204.29.171.80/framer/navigation.asp?charset=utf-8&cc=US&frameid=1565&lc=en-us&providerid=112&realname=HUD&uid=2318084&url=http%3A%2F%2Fwww.hud.gov%2F> on June 27, 2002.
- U.S. Environmental Protection Agency (EPA). 2002. Water Quality Criteria: Nonylphenol. Accessed from <http://www.epa.gov/waterscience/criteria/aqlife.html> on December 16, 2002.
- _____. 2001a. EPA Proposes to Continue with its Existing Approach for Managing Class V Injection Wells. Bulletin #EPA 816-F-01-009. Accessed from <http://www.epa.gov/safewater/uic/classvdetermination.html> on December 5, 2001

- _____. 2001b. EPA's Beach Watch Program. Accessed from <http://www.epa.gov/ost/beaches/2000update/> on March 13, 2002.
- _____. 1999. Wastewater Technology Fact Sheet: Chlorine Disinfection. Doc. No. EPA 832-F-99-062. September, 1999.
- _____. 1998. Information for States on Developing Affordability Criteria for Drinking Water. Published by Office of Water. EPA 816-R-98-002. February.
- _____. 1996. Water Quality Protection Program for the Florida Keys National Marine Sanctuary. Final Report submitted to the EPA under work assignment 3-1, Contract No. 68-C8-0134. Batelle Ocean Sciences, Duxbury, MA, and Continental Shelf Associates, Inc. Jupiter, Florida.
- _____. 1994a. Chlorine: Hazard Summary. December. Assessed from <http://www.epa.gov/ttn/atw/hlthef/chlorine.html> on March 11, 2002.
- _____. 1994b. Integrated Risk Information System (IRIS). 1994. Chlorine: Carcinogenicity Assessment. June 1. Assessed from <http://www.epa.gov/IRIS/subst/0405.htm> on March 11, 2002.
- _____. 1994c. Office Pollution Prevention and Toxics. 1994. Chemicals in the Environment: Chlorine. Doc. No. EPA 749-F-94-010. August. Assessed from http://www.epa.gov/opptintr/chemfact/f_chlori.txt on March 11, 2002.
- _____. 1994d. Office of Water. Drinking Water Treatment for Small Communities. Doc. No. EPA 640-K-94-003. May 1994.
- _____. 1993a. Water Quality Protection Program for the Florida Keys National Marine Sanctuary: Phase II Report. Final report submitted to the Environmental Protection Agency under Work Assignment 1, Contract No. 68-C2-0134. Continental Shelf Assoc., Inc., Jupiter, FL and Battelle Ocean Sciences, Duxbury, MA. February.
- _____. 1993b. Affordability of the 1986 SDWA Amendments to Community Water Systems. Prepared by ICF, Inc. Washington, D.C.: U.S. EPA Drinking Water Standards Division.
- _____. 1974. EPA Identifies Noise Levels Affecting Health and Welfare. April 2. Accessed from <http://www.epa.gov/history/topics/noise/01> on September 18, 2001.
- U.S. Fish and Wildlife Service. 2000. USFWS-listed species in Monroe County, Florida. Published by South Florida Ecological Services Field Office. Updated June 2000. Accessed from http://verobeach.fws.gov/Species_lists/spl-mo.html on October 22.
- _____. 1999. South Florida Multi-Species Recovery Plan. Published by South Florida Field Office. May 18.
- U.S. Geological Survey (USGS). 1997. Environmental Quality and Preservation: Fragile Coral Reefs in the Florida Keys. Prepared by Barbara Lidz. South Florida Information Access OFR-97-453. Accessed from <http://sofia.usgs.gov/publications/ofr/97-453/>.
- _____. 1990. Ground Water Atlas of the United States - Alabama, Florida, Georgia, and South Carolina. Hydrologic Atlas 730-G.
- Vecchioli, John, D.J. McKenzie, C.A. Pascale, and W.E. Wilson. 1979. Active Waste-Injection Systems in Florida. Published by U.S. Geological Survey. Open File Report #79-1296.

- Voss, G. 1988. Coral Reefs of Florida. Pineapple Press, Inc., Sarasota, Florida. 80 pp.
- White, W.A. 1970. The Geomorphology of the Florida Peninsula. Florida Bureau of Geology. Bulletin No. 51.
- Williams, S.L. 1988. Assessment of Anchor Damage and Carrying Capacity of Seagrass Beds in Francis and Maho Bays for Green Sea Turtles. Virgin Islands Resource Management Cooperative; Biosphere Reserve Research Report No. 25.
- Williams, Zully, 2001. Project Manager, Village of Islamorada. Personal communication with Sonya Krogh, URS Group, Inc.
- Wilkinson, C.R. 1996. Global climate change and coral reefs. *Global Climate Change Biology* 2: 547–558.
- _____. 1993. Coral reefs of the world are facing widespread devastation: can we prevent this through sustainable management practices? *In Proceedings of the seventh International Coral Reef Symposium: Guam, Micronesia, 22-27 June 1992*. Mangilao, University of Guam Marine Laboratory.
- Wunderlin, R.P., and B.F. Hansen. 2000. *Atlas of Florida Vascular Plants* (<http://www.plantatlas.usf.edu/>). Institute for Systemic Botany, University of South Florida, Tampa, Florida.
- York, David. 2002. Wastewater Reuse Program, Florida Department of Environmental Protection. Personal communication with Lisa Fretwell, URS Group, Inc. March 13.